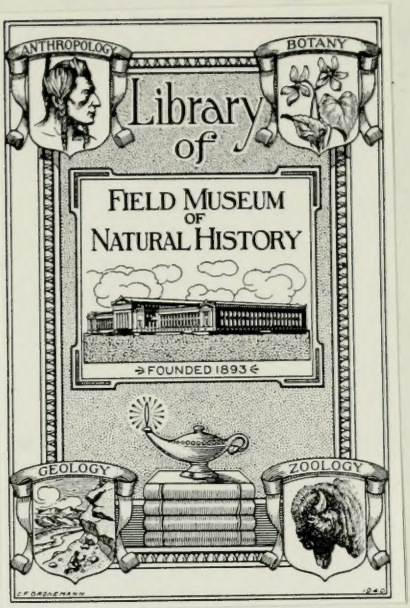
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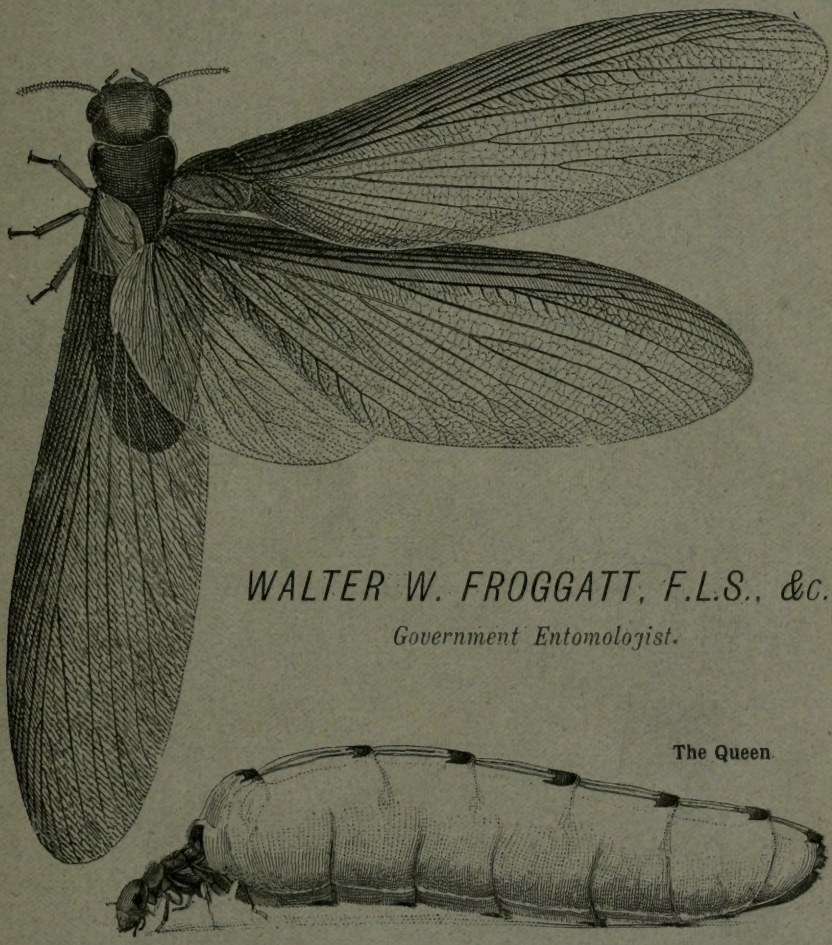
NEW SOUTH WALES

White Ants.

(TERMITIDÆ.)



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Government Entomologist.

MISCELLANEOUS PUBLICATION, No. 874

W. A. GULLICK, GOVERNMENT PRINTER
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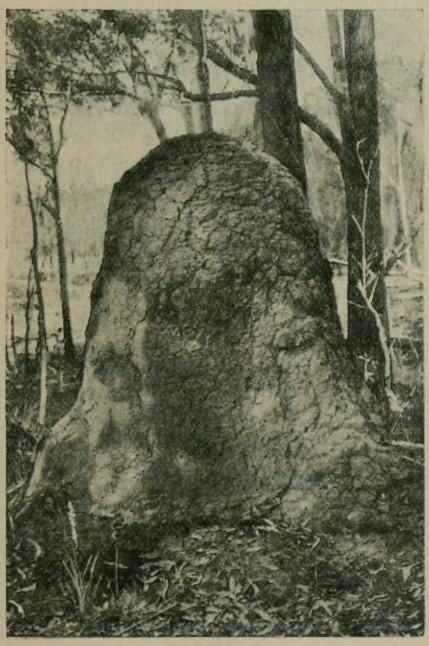
Economic Entomology.

WHITE ANTS (*Termitidæ*), WITH SUGGESTIONS FOR DEALING WITH THEM IN HOUSES AND ORCHARDS.

WALTER W. FROGGATT, F.L.S., &c.,
Government Entomologist.

SINCE my monograph was published in the "Proceedings of the Linnean Society of New South Wales, 1895-7," a great deal of information has been collected, and observations made upon the species then described from Australia. In other parts of the world a number of new species have been described, and quite a boom has set in regarding the literature published regarding this previously neglected family. At the date of my publication,



Domed Nest.

Domed nest with outer wall removed.

Hagen's "Monograph of the Termitidæ of the World" was the only systematic classification of the termites of any importance, and our knowledge regarding their distribution was very limited.

The economic importance of the white ant and its great powers for evil has led to a great deal of correspondence coming to the Department of Agriculture; so that I think that a general summary of the work previously done would be of value to all classes of the public, if written with few technical terms, giving suggestions for checking them, a general account of their habits, and the numbers known to infest this country. It is very unfortunate that the termites have become well known under the name of "White Ants," because, with the exception of their peculiar social habits, they are in no way related to the true ants (*Formicidæ*), which are their most deadly enemies, devouring them whenever they come across them. There is no family of insects on the face of the earth that do more damage to man's industry than the termites. From their countless numbers, subterranean habits, and insidious method of attack, they are very difficult to destroy. Always coming up from below, shunning the light, they work under cover, so that it is not until the damage is done that their presence is noticed. They can eat the centre out of a board or beam until it is as thin as paper, though outwardly perfectly sound until it is touched, when an accidental bump or blow will crumple it up into papery fragments and reveal damages beneath extending into unknown quarters all through the woodwork. In the orchard or garden, plants apparently healthy a few days before suddenly wilt and die. On examination, the stalk snaps off in one's hand, leaving a cavity on the butt; a few tiny yellow-headed creatures scuttling down into the roots remaining in the ground give the clue to the authors of the damage.

In Australia, many thousands of pounds' worth of property are annually destroyed by these insignificant-looking little creatures, and quite a number of instances in the City of Sydney have come under my notice of serious damage being done to public buildings; while in the suburbs they are a constant source of worry to property-owners, particularly on the North Shore line, where the land is comparatively high.

The whole of the roof of one of the largest rooms in the Australian Museum had to be replaced some years ago owing to the damage done to it by white ants. In the Department of Education's buildings in Bridge-street, the whole of the floor of the Records' room was perforated by these pests, and upon examination it was found that the termites had evidently been at work for years, great masses of earth having been carried up and packed between the joists. Within the last six months these pests have been found in the basement of the Town Hall. It is worthy of remark that in these three places recorded, Moreton Bay figs were growing close to the buildings, and it is quite possible that their head-quarters are in the roots of these trees; so that trees in a city like Sydney might form a regular home for white ants, and lead to them doing further damage.

In houses in the suburbs of Sydney it is not an uncommon thing to find the foot of the bed suddenly sink into the floor, where the white ants have come up from beneath and eaten out the wood.

In the course of my profession I have travelled over a great deal of the white ant infested districts of Australia, both along the coast and in the interior, as well as having a large correspondence with persons in all

White Ants Nest (*Coptotermes lacteus*) **made in a bag of wheat.**
Trangie, N.S.W.

parts of the country when collecting material for the determination of our species. This has since led to many questions and inquiries from brother naturalists interested in the subject in other parts of the world.

Prehistoric Termites.

As our fossil fauna in regard to the insect world is very limited and imperfectly known, we have no record of fossil termites; but in the fauna of the Old World they were very well represented, and quite a number have been described from Europe. Many of these have been obtained in amber (which is supposed to be the gum or resinous exudation of some prehistoric conifer), into which the fluttering male and female termites in their marriage flight, as they swarmed out of their nests in these ancient forests, fell and were entombed, passing down through the ages, the remains so perfect in every detail that at the present day entomologists are able to accurately describe them. Others fell into soft ooze, which, drying up rapidly, left the imprint of the tiny creatures long after it had hardened into stone.

In 1848, Professor Heer published his "Ueber fossile ameisen," afterwards translated and published in the "Journal of the Geological Society

of London" in 1850. In this were described several termites, among other insects, that he obtained from the Tertiary beds at Oenigen and Rudoboj. Four years later Dr. Hagen published a report in Germany, describing the fossil termites of the same locality, and pointed out that the climate of Europe must have been very much warmer at that period than under existing conditions to have supported such an abundance of insect life, for out of the sixty white ants alone, a third of them were known from fossils. Between 1855-60, Hagen brought out his "Monograph of the Termitidæ," in which he described all the species known to him or described up to that date; this was published in three parts in a German journal called the *Linnæa Entomologica.*

In 1861, Hagen recorded the discovery of three species in some Sicilian amber in the Oxford Museum. In 1878 Sterzel described a fossil species under the name of *Mixotermes lugauensis*, from the carboniferous strata of Lagau. In America, in 1883, Scudder recorded a number of new forms from the Florissant Tertiaries in his paper entitled "Fossil White Ants of Colorado." In this he described six new species, and gave a general account of fossil termites from other places.

In Brongniart's "Recherché pour servu à l'Histoire des Insects Fossiles," published in France in 1893, other fossil species are recorded.

Distribution generally.

Though England and the northern latitudes of Europe are free from termites, several instances have been recorded of their accidental introduction, chiefly by means of timber from tropical countries. McLachlan exhibited specimens, at a meeting of the Entomological Society in 1874, of a colony that had been discovered in the Palm House of the Royal Gardens at Kew, where they were kept under observation for some time before they were destroyed.

Three species are recorded from southern Europe, chiefly ranging along the Mediterranean sea-board, though one has been found as far north as Odessa, where it did a considerable amount of damage. *Termes lucifugus* is said to be an indigenous species, and has been well known in France from a very early date. In 1853 it appeared as a regular plague in Rochelle, where, not content with damaging woodwork, it found its way into the city archives, where it destroyed many valuable State documents. This species is found in all the southern provinces of France, and has been recorded from all southern Europe, Sicily, Sardinia, Morea, Turkey, Cyprus, Egypt, and Madeira. This is the species that has been monographed by Professor Grassi and Dr. Sandias, who studied them in Catania, Italy.

The second species, *Termes flavicollis*, originally a native of northern Africa, common in Barbary and Algeria, has been introduced into or has spread round the European coast, and is now found in most of the localities where the previous species exists.

The third species, *Termes flavipes*, a common North American form, has been found in the woodwork of the Bath House of Schœnbrun at Vienna, and was probably accidently introduced in timber from its native land.

The termites found in Africa have always attracted the notice of travellers, and Smeathman's account of the large mound-building white ant, *Termes bellicosus*, published as far back as 1781, entitled "On the Termites of Africa and other hot countries," contained the first authentic description of the internal structure of a termitarium, or white ants' nest. The notes and figures that he furnished have appeared in nearly all the popular works on Natural History up to the present time. This species ranges right round the coast of Africa. In Hagen's list, twenty species were recorded from Africa; but since its publication, Messrs. Haviland, Sharp, and others have added many new species, and Dr. Sjostedt, in his "Monograph of the African Termitidæ, 1900," brings the number up to seventy-seven species from the mainland, seven peculiar to Madagascar, and two in Mauritius.

Though most of the larger mound-making species seem to be more or less confined to the coast (as they are in Australia), as might be expected, as we approach the Equator the more numerous and destructive the species become. Nearly every explorer has had something to say about white ants in Africa. Paul Du Chaillu, the famous gorilla hunter, gives a general account of their nests and habits on the west coast in his book, "My Apingi Kingdom." Frank Oates, in his "Matabele Falls," notices them in that country, and figures one of the larger nests. Professor Drummond is sometimes quoted as an authority on white ants, because, in his "Tropical Africa," there is a chapter devoted to these insects; but there is nothing new in this, except the theory he originates that white ants take the place of earthworms in the tropics and improve the soil in the same manner; but this is open to much doubt.

The accidental infestation of the rock-bound isolated island of St. Helena is an interesting instance of the destructive powers of an introduced pest, and the way in which they can increase and multiply under altered or improved conditions. In the year 1840, a captured slaver was brought into the port of Jamestown, where it was condemned, dismantled, and the timbers landed in the town; these proved to be infested with a South American white ant (*Eutermes tenuis*) common in Brazil. These termites, escaping from the timber, became so destructive that several Royal Commissions were appointed to consider the best methods of dealing with them. Melliss, in his work on St. Helena, states that it was estimated that £60,000 of damage had been done by this introduced pest.

Little or nothing seems to be known about white ants in the northern or central portion of Asia; but in Crichton's "History of Arabia" they are said to be very destructive to young trees, which the Arabs protect by coating the bark with sheep dung. Two species are described by Hagen from Schiraz on the Persian Gulf, but beyond this I find no reference till

we come to India, where, in the southern provinces, they are very numerous and destructive, though there does not seem to be a great number of different species. The common species in Ceylon is *Termes taprobanes*, where it does an immense amount of damage; it has a wide range across to Borneo, Sumatra, and Java.

Haviland, in his "Observations on Termites: with descriptions of New Species," published in the Journal of the Linnean Society, 1889, lists and describes forty-six new species from the Malay Peninsula and Borneo, the latter being particularly rich in species.

Peel gives a general account in "Nature," 1882, of the termites of Assam, and Romanis notes those of Rangoon.

In the zoology of the Novara Expedition, Brauer described two species from the Nicobar Islands, and Forbes records them in his "Naturalist's Wanderings in the Eastern Archipelago, 1885," as being common in the Cocos (or Keeling) Islands, where he says they were introduced from the mainland.

In the Phillipine Islands, though few species have been described, they are evidently numerous, for Seoane has given a very interesting account, in the "Entomological Society of Belgium, 1879," of the destruction of a Spanish man-of-war by *Termes dives* while lying in the port of Ferrol.

Doderlein has described a species from Japan, and according to Dr. Knower, the American, *Termes flavipes* has been introduced and is firmly established in that country. I have no records of described species from New Guinea, but D'Albertis notes them as common on Yule Island. No one seems to have collected termites on the islands of the Pacific; but among collections from the New Hebrides, I have had several winged forms of an undetermined *Calotermes*, and *Calotermes longipennis* from the New Hebrides. In the Insect Fauna of Funufuti ("Memoirs," Australian Museum, Part II), Rainbow notes an introduced species on that island.

In the Hawaiian Islands Blackburn collected two species, both introduced from America, and Perkins, in the *Fauna Hawaiiensis*, says that *Calotermes castaneus* is found in the heart of large forest trees, and *Calotermes marginipennis* is the one destructive to wooden buildings in Honolulu.

As might be expected, South America is rich in termites, and as so many capable naturalists have spent years collecting in the tropical forests. the fauna is well known. Hagen listed twenty-seven species, some of which had been collected and described by Walter Bates on the Amazon. Dr. Fritz Müller has contributed largely to our knowledge of the termites found in the Santa Catherina district, in working out their life histories.

Recently Dr. Silvestri has monographed the South American termites, classifying the species previously described by Messrs. Bates, Hagen, Müller, Wasmann, and Kollar, and adding about thirty new species, which brings the South American fauna up to about ninety.

They are well-known pests in most of the West Indies; Cuba has several species. Hubbard has described the habits of those of Jamaica, of which the tree-nest building species is the most common (*Eutermes ripperti*).

Maynard has recorded his observations in "Notes on the White Ants of the Bahamas" (Psyche, 1888) on those found in these islands. Moseley, in his "Notes by a Naturalist on H.M.S. 'Challenger,' 1894," describes them on the Virgin Islands. Hagen lists them from St. Domingo and St. Thomas; and Marshall studied the habits of *Eutermes destructor* in Antigua.

In Central America they are very destructive, and the country is alive with several species that, during the construction of the Panama Railway, did a great deal of damage to the rolling stock, even forming their nests in disused railway cars. Messrs. Dudley and Beaumont kept a number in captivity and observed their habits, notes on which were afterwards published.

Turning to North America, we find *Termes flavipes* is the common species all over the United States; but though it has been known for so many years, its true nest has never been discovered, as far as I can learn, up to the present date. Scudder has described their ravages in Florida, Buckley records two species in Texas, others are known in Mexico, and Osten Saken has studied their habits in California. In the Southern States along the Mississippi they often do a great deal of damage to tropical produce.

In 1879, Hagen described an immense cloud of winged termites that swarmed out at Cambridge, U.S., but they did not reappear the following season. The most northern limit of the termites in the New World is Manitoba, where *Termes occidentalis* was discovered and described by Treherne.

Distribution in Australia.

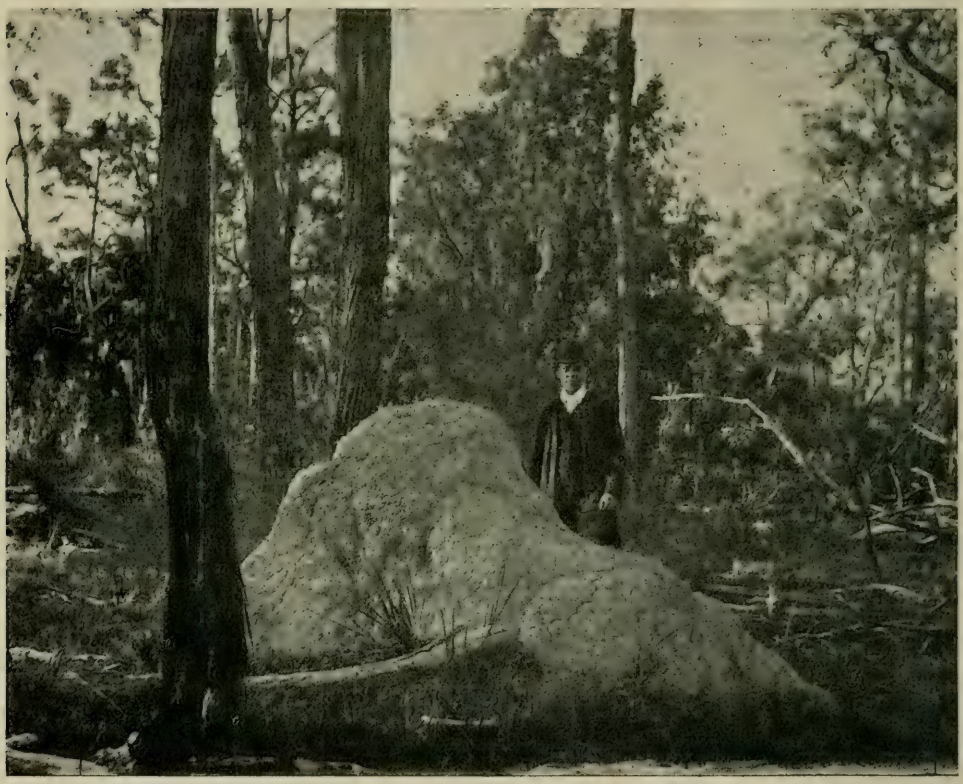
Three species of white ants were described from New Zealand, to which I have added another species, *Calotermes brouni*, after my valued correspondent, Captain Thos. Broun, Government Entomologist in New Zealand, who wrote, "This species originally inhabited the Puriri (*Vitex littoralis*) in our northern forests, where I have frequently cut out the nests containing only a small family."

Four species are recorded from Tasmania, and up to the issue of my monograph there were only six described from Australia.

Since this was written a great deal of information has come to hand that enables us to map out the distribution of the termites in the interior of the country and the western side of the continent. The members of the Horn Exploring Expedition, 1896, brought back several interesting forms from the McDonald Ranges, which were placed in my hands by Professor Spencer for determination. In the vicinity of Kalgoorlie, West Australia, my father collected a number of very interesting forms, many of them peculiar to that district, while his notes on their habits made his work exceptionally valuable.

The eastern coast-line of Australia is chiefly rugged forest country, and termites are plentiful; in southern Gippsland they are a well-known pest,

and northward in the Goulburn Valley (Victoria) they often damage vines and fruit trees in the orchards. In the north and north-western parts of that State they are more or less plentiful in the timbered country, but apparently never form nests of any great size. Coming overland in the South Coast districts of this State, we soon meet with the large dome-shaped nests of *Termes lacteus*, which is found right up the coast at intervals into southern Queensland; these nests are generally dotted over the flats, and



Nest of the Milk Termite *Coptotermes (Termes) lacteus.*
Barber's Creek, N.S.W.

though this species is common about Sydney in colonies, it seldom constructs a regular nest. Two species of *Eutermes* form nests up trees or on stumps about Sydney, and at least half a dozen other forms may be found in dead timber or under logs within a short distance of the town. The same state of things prevails as far as Newcastle, and for some distance farther north. Beyond Rockhampton they are plentiful, though the larger nests are not common; from Mackay, Turner collected five very distinct species.

Towards Townsville they increase in numbers, but, coming to the semi-tropical jungles towards Cairns, they are chiefly arboreal forms along the coast. From Cooktown, and all over Cape York and Thursday Island, the larger nests are very numerous, and form a striking feature of the landscape. At Somerset (Cape York) is to be found one of the most remarkable white-ant cities in the world. Viewed from the sea, and looking up beyond the old Government Residency, now occupied by Mr. Frank Jardine's homestead, it appears as if the plain for a mile or more in extent is covered with pointed pillars 6 to 7 feet in height, broad at the base, and tapering to the summit, forming regular symmetrical pyramids. They are thickly dotted over the plain, often only a few yards apart; the effect is much heightened if the grass has been freshly burnt off, as it had been the first time I steamed past Somerset.

Several writers have noticed this city of the termites. Mosely likens them to kiln chimneys; he says that it gives the country the appearance

View of White Ants Nests, Cape York.

Taken from "A Naturalist in Australia"; S. Kent.

of a pottery district in miniature, and states that many of them are 10 feet in height. D'Albertis, describing them, says: "Termites' nests, both on the hills and plains, measured often 10 feet in height and 13 feet in circumference at the base." He found, upon opening them, that many had been attacked, and often the termites almost exterminated, by large black ants.

On Thursday Island, and many other islands round Cape York, the same form of nest is common. Turning down into the Gulf country and the watershed of the Flinders River and its tributaries is one of the most termite-infested places in the world. Nothing is safe from their depredations; stockyards, fences, and houses only remain intact for a few seasons,

in spite of all precautions. As soon as a branch dies it is attacked, and in many places no stumps or dead wood is left in the scrubby forests. On the table-lands everything is swept up, as it were, by these invisible gnomes, who, as forest scavengers, do their duty to perfection. If one cuts some grass for a bed, and leaves it lying upon the ground for twenty-four hours, anywhere on the Lower Flinders, it will be cut up into fine chaff by the termites that have swarmed up from the ground beneath, attracted by the scent of the drying grass; and if one is inexperienced enough to leave his blankets upon the top of it he will find all the lower folds riddled with holes. All kinds of implements that had been left out in the paddocks, such as earth-scoops and waggons, on the Cambridge Downs Station, were brought in with the felloes of the wheels (hard, seasoned timber) gnawed to a shell; while the storekeeper had to be continually turning over his stock, or he would find the large white termite (*Termes errebundas*) boring galleries through rolls of mosquito nets, books, and boots, and making nests in the cart-saddles. They made their way into the cases of jam and tinned meats, carrying the clay in between the tins, and causing them to rust and spoil the contents. At a hut on this station where I used to camp, the sides were built of upright saplings of ti-tree, about 6 inches in diameter; the termites, coming up from below, had eaten out the centre, reducing most of them to pipes of bark. In the silence of the night I have lain awake listening to the millions of tiny jaws gnawing at these timbers, voices of the night as strange and uncanny as one could well imagine.

Nest of the Spinifex Eutermes
(Eutermes triodiæ.)
Hull's Creek, Kimberley, W.A.; 14 feet high.

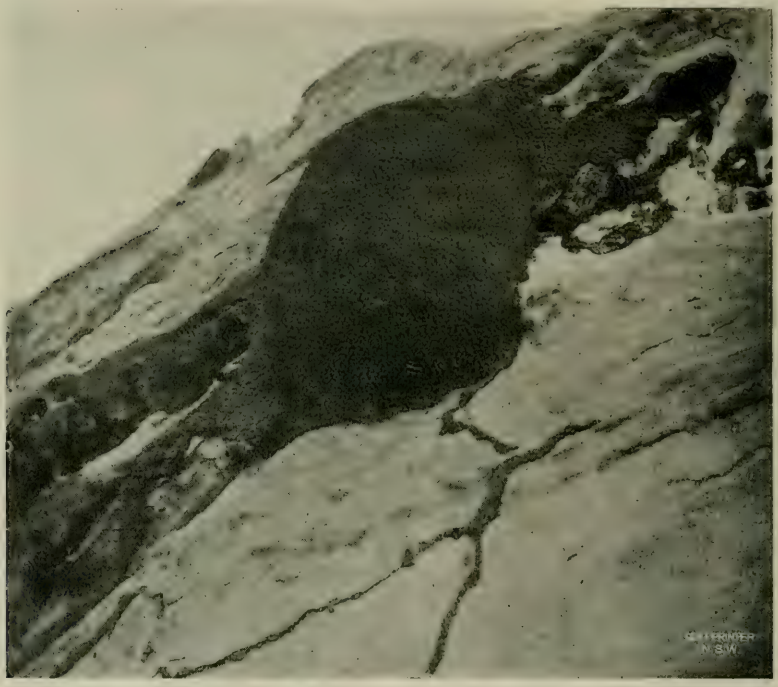
Past Normanton onwards to Port Darwin we are still in thickly-infested country, and about 10 miles out of Palmerston find some of the tallest ant-nests in the world. In the same district are also found the magnetic nests, remarkable for always pointing north and south.

In that portion of north West Australia stretching across from Cambridge Gulf to Roebuck Bay, known as the Kimberley district (where I spent twelve months), and probably as far as the De Grey River, all through the open forest flats and along the edge of the sandy "Pindan" country, are found numbers of large, broad nests, from 5 to 6 feet in

Nest of the Magnetic White Ant *(Termes meridionalis.)*. Near Palmerston, Port Darwin.

height, constricted at the base, but swelling out on the sides in rounded masses, on the sides overlapping each other as additions have been made to the main portion, while the summit is broad and rounded, giving them a somewhat irregular mushroom shape, which are figured by Saville Kent in "The Naturalist in Australia."

I have no record of the absence or otherwise of termites on the large tract of treeless country stretching round to North-west Cape, but the



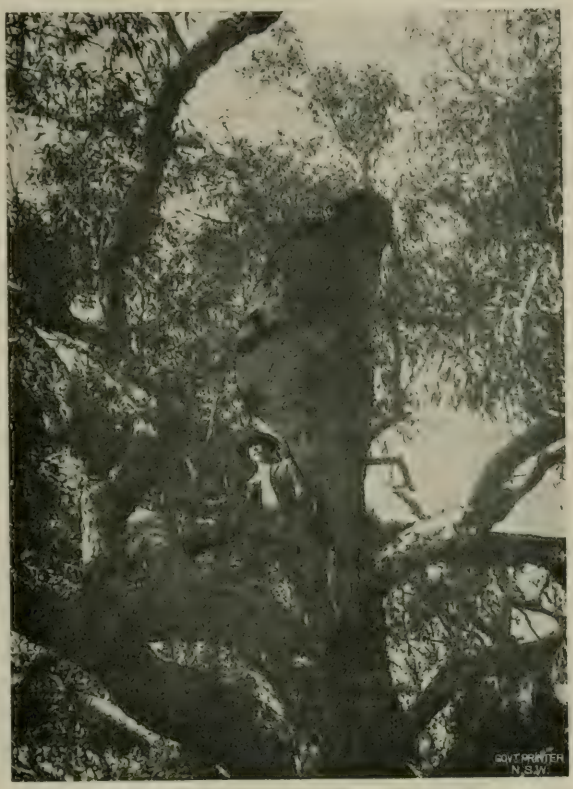
Nest of the Pale Coloured Eutermes *(Eutermes fumipennis)* built on the top of a sandstone rock at Manly, N.S.W. The dark lines are covered galleries leading down to the ground.

smaller termites probably will be found in ground among the grass roots. The coastal districts of West Australia have not been examined for these insects, but, as before noted by my father's investigations about Kalgoorlie, and Spencer in the more central districts, we have a very good idea of the termites found in the interior.

Structure of Nests or Termitaria.

The nests of white ants may be divided up into a number of different groups, though the members of the different genera seem to form a more or less uniform plan of structure. Many species form no regular nest,

simply taking up their abode under a log or stone, and the queen and eggs may be discovered in turning over the sheltering log; others, we find, though constructing very elaborate nests in some districts, in other places, though belonging to the same species, simply hide in the fallen wood or burrow underground. Most of the turret nests, which will be described in the notes under the different species, have a well-defined clay wall or outer covering enclosing the true woody nest, and rise directly from the ground; in the first instance commenced over a log or stump, which is gradually absorbed into the structure and enveloped in the outer clay covering.



Arboreal Nest of the common Pale Eutermes
(Eutermes fumipennis).
Sampson Vale, Queensland.

The arboreal nests have no clay in their structure when any distance from the ground, but when close have an admixture of earthy particles all through the outer portion.

The Classification of Termites.

Most of the earlier entomologists, when treating of white ants, placed them under the order *Neuroptera*, or at best formed a sort of halting-ground between the *Orthoptera* and the former under the title of *Pseudo-Neuroptera*. Others have followed Dr. Packard, and included them in his new order *Platyptera*—flat-winged insects, in which he placed them together with the *Psocidæ* and *Perlidæ*, with which, except in the shape of the wings, they seem to have very little in common.

Among the very earliest forms of insect life in the primeval world, insects allied to *Neuroptera* and *Orthoptera* seem to have been most prominent, and cockroaches and white ants, so closely allied to present

existing species, have been found, so that there has been no difficulty in classifying them.

If the structure of the wing is to be taken into consideration, there can be no doubt that the discovery of the giant termite from Port Darwin—*Mastotermes darwiniensis*, described by me in the "Proceedings of the Linnean Society of New South Wales"—brings them almost into touch with the family *Blattidæ* (cockroaches). Termites under some circumstances look so like earwigs that one of our greatest authorities on the *Neuroptera* actually described a supposed "wingless termite" from Japan under the name of *Hodotermes japonicus*, but in the following volume appeared a note from the author stating that he had discovered, upon comparison with a Japanese *Forficula*, that his new species was a damaged earwig. Dr. Hagen says, in the "Proceedings of the Boston Society of Natural History, 1868," the three families *Termitina*, *Blattina*, and *Forficulina* are co-ordinated and very nearly allied.

Minute anatomical details may bring them into line with some of the *Neuroptera*, but on the comprehensive grounds that all the large divisions of insects were classified upon, into what are known as Orders, the outward structure has been taken as the standard, and they take their group-name from the form and structure of the wings. Now, the termite wings are much more like straight wings (*Orthoptera*) than lace wings (*Neuroptera*); those of the genera *Termes*, *Eutermes*, and allied groups being even more primitive in their venation than the more specialised *Mastotermes* and *Calotermes*.

In their metamorphoses a baby termite undergoes only a gradual change, like the little cricket or grasshopper—an active-feeding creature from the time it emerges from the egg, till, by successive moults, it gradually reaches its full size, and with a final casting of the skin comes forth a perfect worker, soldier, or winged white ant. There are no abrupt changes from larva to pupa and pupa to perfect insect as we see in the lace-winged flies.

The life of a termite's nest is most remarkable from the very distinct forms or casts of insects that are produced from the same eggs with no apparent treatment of the baby larvæ in their upbringing (though it may exist, as the different feeding of the bees produce the queen bees). The founding of a termite city has been told in my "Nature Study," published in the *Agricultural Gazette*, N.S.W. (1903), so that only a brief recapitulation is necessary here. When the swarms of winged males and females are ready to emerge from a termitarium, the workers cut slits through the solid clay walls, which the soldiers guard until a suitable time, generally late in the afternoon, when they withdraw, and the winged creatures swarm out in a continuous stream, flitting along with their loose fragile wings, and swarming round the lighted lamps in the early summer evenings, where they are well known under the name of "Flying-ants," and drop their wings all over the place. Out of the millions that swarm out of a single nest, perhaps only half-a-dozen couples

may survive their many enemies and found a fresh colony, for Nature is very lavish in her superabundance of life. The typical winged termite is dark brown or yellowish, with a more or less rounded head, with many-jointed antennæ, the segments of which are bead-like in form and fringed with fine hairs; the eyes are large and well developed, and most species have simple ocelli on the top of the flattened head, while the mouth parts beneath are hidden from view. The thorax is short and broad, attached to the head by a very short neck, and the legs well adapted for running about; the wings consist of two pairs, the front and hind ones, elongate and narrow, rounded at the tips, and when laid over the back reaching a considerable distance beyond the tip of the elongate flattened abdomen, which is round at the tip, and furnished with two short-jointed appendages called the cerci, or anal appendices. Th venation of even the most specialised forms is very simple when compared with the complicated network of veins observable in the wings of most insects, and most of them are opaque or blackish in tint; at the base of each wing is a curious cross nervure, which enables them to break off their wings when they have served their purpose of flying out from the nest, and would be only an encumbrance when they started housekeeping under logs or in the ground. The new nest is started by this pair, a male and female, popularly called the king and queen; and after copulation the female becomes gravid, and her abdomen becomes a mass of egg-tubes, increasing rapidly in size, until finally, while the rest of the head, thorax, and legs have remained the original size, the abdomen becomes a circular, sausage-like shape, white, with the integument so swollen that the closely-fitting bands of chiton that once covered the whole surface are so divided that they only form dark transverse bands. Here she remains for the term of her natural life, and, if belonging to a mound-forming species, the workers and soldiers of her species, who are always wandering about in small companies, and thus find the helpless pair, set to work to wait upon them, and form the foundations of a nest over and around them, tending the eggs as they are laid, feeding the larvæ as they are hatched, and finally, reinforced by them as they reach maturity, the first members of the small colony soon increase the size of the mound, and form a regular nest. What becomes of the prince consort after the queen is fairly started as an egg-laying machine I do not know; he does not appear to be necessary, and apparently disappears. I have never found one in the regular royal chamber in which the queen is installed in every well-constructed nest, though writers upon some of the African species always mention the royal pair in the queen chamber. The nest is full of intermediate forms of larvæ from the size of a pin's-point of white matter to the almost fully-developed soldiers and workers, showing the structural difference of the head, but still requiring the final moult to be perfectly formed. The immature winged forms are easily recognised by the large soft bodies and rounded wing-pads standing out on the shoulders. After the royal pair we come to the soldiers and workers, which are sexless.

The workers are usually short and broad in proportion to the soldiers, have the head rounded, with similar antennæ to the winged form, but without eyes or ocelli, the large powerful jaws, which are responsible for all the damage caused by the white ant, hidden when viewed from above by the rounded upper lip. The thorax is short, with stout legs, and no traces of wings, with the segmented abdomen somewhat curved on the sides to the rounded tip. The soldier has the general appearance of the worker, but the head is usually larger or more elongated, with the jaws produced in front of the labrum or upper lip into a pair of sabre, sickle, or tooth shear-bladed jaws, which meet at the tips or can be folded over each other. While the legs and thorax are similar to that of the worker, the abdomen is usually smaller and more slender in proportion. The soldiers are sometimes almost as numerous in the nest and colonies as the workers; but in others you may find hundreds of workers to every soldier, probably because less protection is required in the underground nests. The soldiers act as the police or protectors of the colony, rushing from all quarters as soon as a break occurs, and holding the breach, until the workers can repair it with fresh clay, which they bring from the interior. It is on the workers that the whole economy depends: they tend the queen, remove and look after the eggs, feed the helpless pupæ, and do all the building and construction of the termitarium.

Though the queen is apparently the head-centre and sole source of life and reproduction of the countless multitude that inhabit the nest, we sometimes come across greatly-developed pupæ produced from the embryonic winged forms, though the wing pads have even become aborted, which for want of a better name, we call supplementary queens. I had twenty-two specimens sent me taken from a small nest in southern Queensland, and have frequently found two or three in a nest.

These supplementary queens have been noticed in other countries, and Dr. Müller, when working out the life histories of the white ants at Santa Catherina, Brazil, obtained thirty-one specimens in a nest.

Following up the relationship of the *Termitidæ* with the order *Orthoptera*, I think if we take the *Blattidæ* (cockroach) as the end of the order, followed by the termites and *Embiidæ*, they come very naturally together as two more families in the order, without running them into the *Pseudo-Neuroptera*.

Hagen, in his monograph, based his classification of the family upon the structure of the wings, ocelli, number of joints in the antennæ, shape of thorax, and tibial spurs, which I followed in my work on the Australian species. While the structure of the wing forms is very distinctive in defining generic species, it will be found that the study of the soldiers is one of the best methods of defining the species, and these differences are constant; when sometimes it is very hard to point out the difference between two species in the perfect-winged form, even when the soldiers can be readily distinguished. In dealing with the Australian species I

placed them in four sub-families, based on the wing structure, placing the *Calotermitinæ* as the first division.

Desneux, in his paper, "Apropos de la Phylogenic des Termitides," published in the "Annals of the Societé Entomologique de Belgique," last year (1904), makes some critical remarks upon my classification, in which he places the sub-family *Termitinæ* first, with the *Rhinotermitinæ* as a group with them, and the *Hodoterminæ* as a group of the *Calotermitinæ*, forming a third sub-family, *Mastotermitinæ* to contain my genus *Mastotermes*. If, however, we take the robust termites as those most closely allied to the cockroaches, we must commence with *Mastotermes*, following up with *Calotermes*, with the more feeble-winged *Termitinæ* connecting them with the *Embiidæ*.

Wasmann has created a new sub-genus (*Coptotermes truncatus*) for a termite in Madagascar, which has the front of the head furnished with an opening above the jaws, from which it can discharge a protective fluid when molested; this appears to be a valid distinction worthy of generic rank, and will include two of my species, and a third Wasmann has since described from West Australia.

In adopting Desneaux's new sub-family for my thick-winged termite from Port Darwin, and thus taking it out of the *Calotermitinæ*, I still retain my two other sub-families, and the *Rhinotermes*, while coming after the *Calotermes*, are very easily seperated by their wing structure.

The following is the order in which I would place them:—

ORDER—ORTHOPTERA.

FAMILY—TERMITIDÆ.

SUB-FAMILY I.—MASTOTERMITINÆ.	*Genus* I.—*Mastotermes.*
II.—CALOTERMITINÆ.	I.—*Calotermes.*
"	II.—*Stolotermes.*
III.—RHINOTERMITINÆ.	I.—*Rhinotermes.*
IV.—GLYPTOTERMITINÆ.	I.—*Glyptotermes.*
V.—HETEROTERMITINÆ.	I.—*Heterotermes.*
VI.—TERMITINÆ.	I.—*Termes.*
,,	II.—*Coptotermes.*
,,	III.—*Eutermes.*

SUB-FAMILY I.—MASTOTERMITINÆ.

Genus I.—*Mastotermes*, Froggatt.

The head large, nearly as long as broad, flattened on the summit; eyes large, projecting; ocelli prominent, with antennæ composed of

thirty or more segments; prothorax saddle-shaped, outer margins turned up, with the scapular shield as long as meso and meta thorax combined; the fore wings different from the hind ones in possessing fewer parallel nervures between the costal and sub-costal veins, the upper portion or fore margins of both pair crossed with stout nervures, and the whole of the wings finely reticulated.

The Thick-winged Termite (*Mastotermes darwiniensis*, Froggatt).

This is a rather common species of white ant in North Queensland, Port Darwin, and Kimberley, N. West Australia, where in the summer time they are often found flying round the lamps at night, but nothing is known about their habits, nests, or the workers or soldiers. It is our largest known species, measuring $1\frac{1}{3}$ inches in length to the tip of the folded wings, with the body about $\frac{3}{4}$ of an inch in length. Its general colour is chestnut brown, with the head of a more rusty red tint, and the

Winged Male White Ant
(Mastotermes darwiniensis).
North Queensland.

antennæ dull yellow. The wings are semi-opaque, with a light ferruginous tint, and the numerous branching parallel nervures pale reddish brown. It will be very interesting to find out the nest of this species which can only be done by a resident where the winged forms are found.

Sub-family II.—Calotermitinæ.

The members of this group have robust wings, reddish brown in the typical *Calotermes*, with the front parallel nervures connected by a number of cross nervures, or veinlets forming a network of irregular cells. The scapular shield has five or more nervures branching from the base, and in some genera the neurations of the fore and hind pair of wings differ.

A number of fossil forms have been described, for which new genera have been created, and other recent species found in the Old World and America are not represented in Australia. The genus *Stolotermes* is included here, for though not found on the mainland, one species has been described from Tasmania, and two from New Zealand.

Genus I.—*Calotermes*, Hagen.

These termites do not construct regular nests, but live in small communities in tree trunks or fallen logs, often not more than a hundred in a colony, which consist chiefly of immature winged forms and workers; the soldiers in some species are often very scarce, and form a very small unit in the nest. The perfect insects are usually of a light reddish brown, and are easily recognised by the more complicated venation of the wings. The soldiers have large heads, dark reddish brown, the jaws black; the latter are thickened, stout and blunt, turned in at the tips, and the jaws are irregularly toothed on the inner edge on the opposite sides. Seven species are described from Australia, and one from New Zealand; others are found in various parts of the world.

Synopsis of Species, winged forms, and soldiers.

1. *Calotermes convexus*, Walker. Ferruginous, wings pale brown. Antennæ, 13-jointed; wings with 12 oblique nervures.
2. *Calotermes insularis*, White. Bright ferruginous, wings hyaline, very long; with 9 oblique nervures.
3. *Calotermes irregularis*, Froggatt. Ochreous, wings pale ochreous, with 13 oblique nervures. Antennæ, 19-jointed.
4. *Calotermes improbus*, Hagen. Chestnut brown, head darkest, wings wanting. Antennæ, 20-jointed.
5. *Calotermes longiceps*, Froggatt. Winged form immature. Soldier with head and jaws longer than thorax and abdomen.
6. *Calotermes robustus*, Froggatt. Dark ochreous wings, semi-opaque. Antennæ, 19-jointed.
7. *Calotermes brouni*, Froggatt. Dark reddish brown, wings fuscus, with 13 oblique nervures. Antennæ, 14-jointed.
8. *Calotermes adamsoni*, Froggatt. Ferruginous on head, rest more ochreous, wings pale fuscus, with 9 oblique nervures. Antennæ, 16-jointed.

Broun's Calotermes (*Calotermes brouni*, Froggatt).

This is a very distinct species sent to me by Captain Broun of New Zealand, under the idea that it was *Termes australis*. He says that "This species originally inhabited the Puriri (*Vitex littoralis*) in the northern forests, where the nests consisted of small families. It has been found in buildings as far south as Tauranga, and is widely distributed throughout the Auckland district, even where the Puriri does not grow. This he considers is to be accounted for by the practice of using blocks of this wood for foundations of houses when containing colonies of these calotermes, which afterwards eat their way upwards into the Kauri flooring, and sometimes make their way up the wall studs to the roof, when in the softer Kauri timber, they are more destructive. It is a small dark-winged white ant, under ½ an inch in length, with the body about ¼ of an inch in length. The soldier with a dull dark yellow head, twice the length of its breadth, with broad stout jaws, slender at the tips, with the right hand one furnished with three stout teeth, and the left hand one with only one in the centre.

The Fine-winged Calotermes (*Calotermes robustus*, Froggatt).

This was described from a single, very perfect specimen taken at Sans Souci, near Sydney, flying round the lighted lamp in a house. It resembles *C. insularis* in size and colour, but differs in having the head convex and not flattened in front, a smaller prothorax and the fine reticulation of the wings, which are very different to any other species examined by me. It is a dark dull yellow-coloured insect with semi-opaque wings, and measures ¾ of an inch to the tip of the wings, and nearly ½ an inch to the tip of the abdomen, and 19-jointed antennæ.

The Common Calotermes (*Calotermes longiceps*, Froggatt).

This is our common species, often met with in small communities of from twenty to one hundred, generally composed of immature winged forms, workers, and only two or three soldiers. I have never been able to obtain the perfect winged forms, though they lived in captivity for months. They form irregular cavities and narrow galleries in the hard eucalyptus logs.

The immature winged forms measure ½ an inch in length, and, like the worker, are stout and cylindrical in form. The soldier measures slightly over ½ an inch in length, with the head and jaws combined as long as thorax and abdomen. The head is very large, longer than broad, bright reddish brown; black jaws, having three small, irregular teeth on the left-hand side, and one large angular one on the opposite side; the antennæ very slender, composed of twenty joints.

Hagen's Calotermes (*Calotermes improbus*, Hagen).

The winged form is of a general chestnut-brown colour, with the head somewhat darker, and was described by Hagen from a specimen without wings collected in Tasmania, slightly over ½ an inch in length. The identity of this species will always be doubtful.

Walker's Calotermes (*Calotermes convexus*, Walker).

This species was described from a specimen taken in Tasmania. Hagen, in examining the type, says, in his monograph, where he redescribes it, "that the somewhat larger *Termes obscurus* from Swan River, West Australia, is not otherwise different from this one. Between the claws is seen a plantula. This species resembles *Calotermes improbus*, and whether it should remain separate is a matter for further consideration, though it is much smaller. The workers and soldiers, described by Walker as belonging to *Termes australis* are probably those of *Calotermes improbus*. He gives the length of the body as 1½ lines, head longer than broad, ocelli close to the eyes, antennæ shorter than head, probably 13-jointed. Soldier 3 lines in length, with reddish-yellow oval head, flattened, and ferruginous in front; jaws dark, almost straight, with two broad teeth. I have not been able to identify this termite in my collections.

Long-headed Calotermes (*Calotermes irregularis*, Froggatt).

The winged form ⅔ of an inch to the tip of the pale ochreous wings, and about ⅓ of an inch to the tip of the body. The head is rusty red, the thorax and abdomen dark dull yellow, with the under surface lighter coloured.

The soldier has a reddish head, with black jaws, longer than broad, and pale dull yellow thorax, and is about ½ an inch in length, with head and jaws taking up nearly half of it; antennæ 19-jointed, with the jaws stout and thick, with several small teeth along the left-hand jaw, and two long angular ones on the right side. This species was obtained by Turner in small colonies in the Mackay district, Queensland.

The Long-winged Calotermes (*Calotermes insularis*, White).

This species was described by White from winged forms taken in New Zealand, but Bauer records it from New Holland. I received a dried pinned specimen from the National Museum taken near Melbourne, Victoria, which has the typical long wings of this species, and agrees in other details. The body measures under ½ an inch in length, and nearly an inch to the tip of the wings. The head is longer than broad, with large eyes and ocelli. Antennæ broken. The prothorax very large, broader than long. Wings four times the length of the breadth and rather sharp at the extremities.

Adamson's Calotermes (*Calotermes adamsoni*, Froggatt).

This white ant is common in the Uralla district, where they are found in small families in dead logs and stumps, forming irregular galleries.

The winged form has the head ferruginous; thorax dull yellow; wings pale fuscus; it measures nearly $\frac{2}{3}$ of an inch in length to the tip of the wings, and $\frac{1}{4}$ of an inch to the tip of the body. The wings are long and slender, rounded at the tips. The soldier has a bright reddish brown head, a little longer than broad and flattened on the summit; jaws short and stout, with three sharp incised teeth on the upper portion and one large one below on the left hand, and only one curved fang near the tip, and a broad angular tooth below on the opposite side. The winged form differs from the other members of the genus in having no ocelli, but as the wings are so typical it should, I think, be included in the genus.

Genus II.—*Stolotermes*, Hagen.

These termites are allied to the members of the American genus *Hodotermes*, but differs in having few joints in the antennæ; ocelli present in the winged insects, and a heart-shaped prothorax; the tarsi with the first joint as long as the succeeding ones. The wings are small with the straight medium nervure like those of the *Eutermes*. They live in small communities like the *Calotermes*, and though no species have been found on the mainland, one has been described by Hagen from Tasmania, and another by Brauer from New Zealand; and it is apparently not uncommon in some districts.

Stolotermes bruneicornis, Brauer.

It is a dark brown species with fuscus wings, measuring slightly over $\frac{1}{2}$ an inch in length, and about $\frac{1}{4}$ to the tip of the body. Antennæ, 16-jointed. Hagen described it from three specimens in the Berlin Muesum. I have never been able to find it in Tasmania.

Stolotermes ruficeps, Brauer.

This species was collected during the voyage of the "Novara" at New Zealand, and is apparently not uncommon, as I have had specimens sent from Drury several times. It is slightly smaller than the former species, of a more reddish-brown colour, with a spherical head and fifteen joints on the antennæ. The soldier has a bright yellow head, longer than broad, stout curved jaws, with two blunt teeth in the centre, and a pair of distinct facetted eyes.

Sub-family III.—Rhinotermitinæ.

This division contains the single genus *Rhinotermes*, which Hagen used as a sub-genus, placing in it three species from the West Indies and Brazil, and a fourth from Australia, which he distinguished chiefly by the structure of the front part of the head, which is cleft, and the venation of the wings.

Genus I.—*Rhinotermes*, Hagen.

These termites have the scapular shield broad and convex at the cross suture; the main parallel veins stout and connected with the nervures like that of *Calotermes*, and the whole wing covered with fine wrinkles or ridges. The head is broad, furnished with small eyes and ocelli, and 20-jointed antennæ; the front of the thorax not as wide as the head. Two species are recorded from Australia. (1) *Rhinotermes intermedius*, Brauer. Pale ochreous, wings pale ferruginous; eyes and ocelli large in proportion. (2) *Rhinotermes reticulatus*, Froggatt. Pale ferruginous, wings reddish brown, eyes and ocelli small.

Rhinotermes intermedius, Brauer.

This termite forms small colonies all along the eastern coast, generally in stumps covered with their dead bark, under which they tunnel, but are occasionally found under dead logs. The winged form has the upper surface pale ochreous, with pale ferruginous semi-transparent wings, measuring over ½ an inch to the tip of the wings, and about ⅓ to the tip of the body. They are easily distinguished by the reticulated delicately crenulated wings and curious cleft forehead.

The soldiers are timid creatures, rushing off to hide as soon as they are disturbed, and consist of two very distinct varieties. The large one about ¼ of an inch in length, with large yellow broad head, furnished with long spade-shaped labrum and short curved jaws with two sharp teeth on the left side and one on the right. The minor soldier is fully a third smaller, with the head small and pear shaped; the jaws long and slender-toothed in the same manner, and curving over at the tips; very long palps, and 16-jointed antennæ.

Rhinotermes reticularis, Froggatt.

This species is the common one at Kalgoorlie, West Australia, and takes the place of the eastern form; it is smaller, with a more ferruginous tint; the wings lighter coloured with tawny nervures. It has the same peculiar structure of the head and two distinct kinds of soldiers.

They were found in a dead sheoak stump at Kalgoorlie by my father in March, when the winged forms were emerging. Others were obtained at Palm Creek, Central Australia, by the Horn Expedition.

SUB-FAMILY IV.—GLYPTOTERMITINÆ.

This division contains a single genus formed by me for the reception of the three species of small dark-coloured termites living in small communites in the trunks of trees, the soldier and workers of which are elongated and cylindrical in form.

Genus I.—*Glyptotermes*, Froggatt.

The head is broad, with moderately large eyes, with the ocelli almost touching them; antennæ 13-15-jointed, springing from a circular cleft

in front of the eyes. The prothorax rounded on either side; long slender dark-coloured wings, with the three parallel nervures running close to each other, the second often merging into the front (costal) one in the middle, but always free at the extremity, and the oblique nervures are often composed of rows of dots.

1. *Glyptotermes eucalypti.* Soldier, antennæ 14-jointed, three sharp angular teeth on each side. Head long, truncate in front.
2. *Glyptotermes tuberculatis.* Soldier, antennæ 15-jointed, a stout spine standing out in front on sides of head; two teeth on left-hand jaw and one on right.
3. *Glyptotermes brevicornis.* Soldier, antennæ 13-jointed. Very rugose on front of head; three teeth in left and two in right-hand jaw.
4. *Glyptotermes iridipennis.* Winged form (only known), antennæ 15-jointed; wings very long and slender.

Glyptotermes eucalypti, Froggatt.

This is the common species of the genus about Sydney, and is only found by cutting off the outer rough bark of the Swamp Mahogany (*Eucalyptus robusta*). The termites, working through from the decaying centre of the trunk, burrow through the living sap-wood and inner bark, into which they gnaw narrow circular passages in all directions, so constricted that one cannot pass the other and they must work independently. They live in small communities, the bulk of which are workers or larval forms, perhaps fifty in a colony, with very often only two or three soldiers among them. The workers and soldiers are slender and cylindrical in form, only differing outwardly in the shape and structure of the head, which in the soldier is pale reddish yellow, with 14-jointed antennæ; stout short jaws turning over at the tips with three sharp angular teeth on either side; in the worker the head is spherical and of a pale yellow tint.

The winged termite is chestnut brown, with semi-opaque slender wings four times as long as broad. It measures to the tip of the wings under $\frac{1}{3}$ of an inch, and slightly over $\frac{1}{6}$ to the apex of the body; it is much smaller in proportion to the workers and soldiers than any of the other species. The eyes are large, ocelli oval, the antennæ 14-jointed, the prothorax nearly as broad as the head, broader than long, and slightly concave in front.

Glyptotermes tuberculatus, Froggatt.

This species comes from Uralla, New South Wales, where they were cut out of a log; I have not seen it from anywhere else. The winged termite is of a general pale dull yellow colour, with transparent wings, and dark nervures. It measures $\frac{1}{2}$ an inch in length to the tip of the wings, and just under $\frac{1}{4}$ to the tip of the body. The soldier has the head bright reddish brown, black jaws, prothorax ochreous, and the rest dull yellow. It measures $\frac{1}{4}$ of an inch, of a slender cylindrical form. The worker of very similar shape except that the head is spherical. The jaws of the

soldier are short, with two stout angular teeth below the tip on the left side, with one large one at the base on the left side. A stout cylindrical spine stands out on either side of the front of the head.

Glyptotermes brevicornis, Froggatt.

This is a species collected by Turner in the Mackay district, Queensland, of a similar colour, but smaller than *G. tuberculatus;* having small eyes not standing out on the sides of the head, and 13-jointed antennæ. The wings short, slender, and about twice as long as broad.

The soldier has a head twice as long as broad, rounded behind, but straight upon the sides; pale rusty red at base, but much darker in front, which is very rugose above the jaws; the latter short with three small angular teeth on the left jaw, and two larger ones on the right. Length under $\frac{1}{3}$ of an inch, body elongate and cylindrical. The smaller worker has the rounded head and prothorax pale yellow, with the body like that of the soldier, only more hairy.

Glyptotermes iridipennis, Froggatt.

This is a dark brown termite, with clouded light reddish brown wings. It measures $\frac{1}{2}$ an inch to the tip of the wings, and $\frac{1}{4}$ to the apex of abdomen. The head is longer than broad, convex, and sloping down in front; small eyes; 15-jointed antennæ. The wings are very long, four times that of the breadth, slender, and slightly pointed at the tips. The type, which was mounted on card, comes from Frankston, Victoria; I have not seen any other specimens.

Sub-family V.—Heterotermitinæ.

Differing from the last division in having the head longer than broad, and the absence of ocelli. The costal and sub-costal nervures not in contact. It contains a single genus, created for the reception of a very distinct form from Kangaroo Island, South Australia.

Genus I.—*Heterotermes*, Froggatt.

Besides the definitions in the sub-family, the head is nearly quadrate, the eyes very small and not projecting; antennæ 16-jointed. Wings nearly thrice as long as broad, with the scapular shield small and angular.

Heterotermes platycephalus, Froggatt.

The type was received from Adelaide, and collected on Kangaroo Island some years before. It is a very curious termite differing from all known species in the almost square head and thick antennæ. In the Macleay Museum there are four other specimens labelled South Australia.

The general colour is dark chestnut brown; the antennæ barred with lighter bands at the base of each segment; the wings of a pale smoky tint. It measures $\frac{1}{2}$ an inch to the tip of the wings, and under $\frac{1}{4}$ to the apex of abdomen.

Sub-family Termitinæ.

In this division the scapular shield is angular, slightly rounded above, but transverse below, traversed by four distinct parallel nervures. The costal and sub-costal nervures running parallel but widely separated from each other, with the median and sub-median slender, the former divided into one or more forks at the apex. It contains three well-defined genera, two of which, *Termes* and *Eutermes*, have a wide range, but *Coptotermes* is confined to the Old World and Australia.

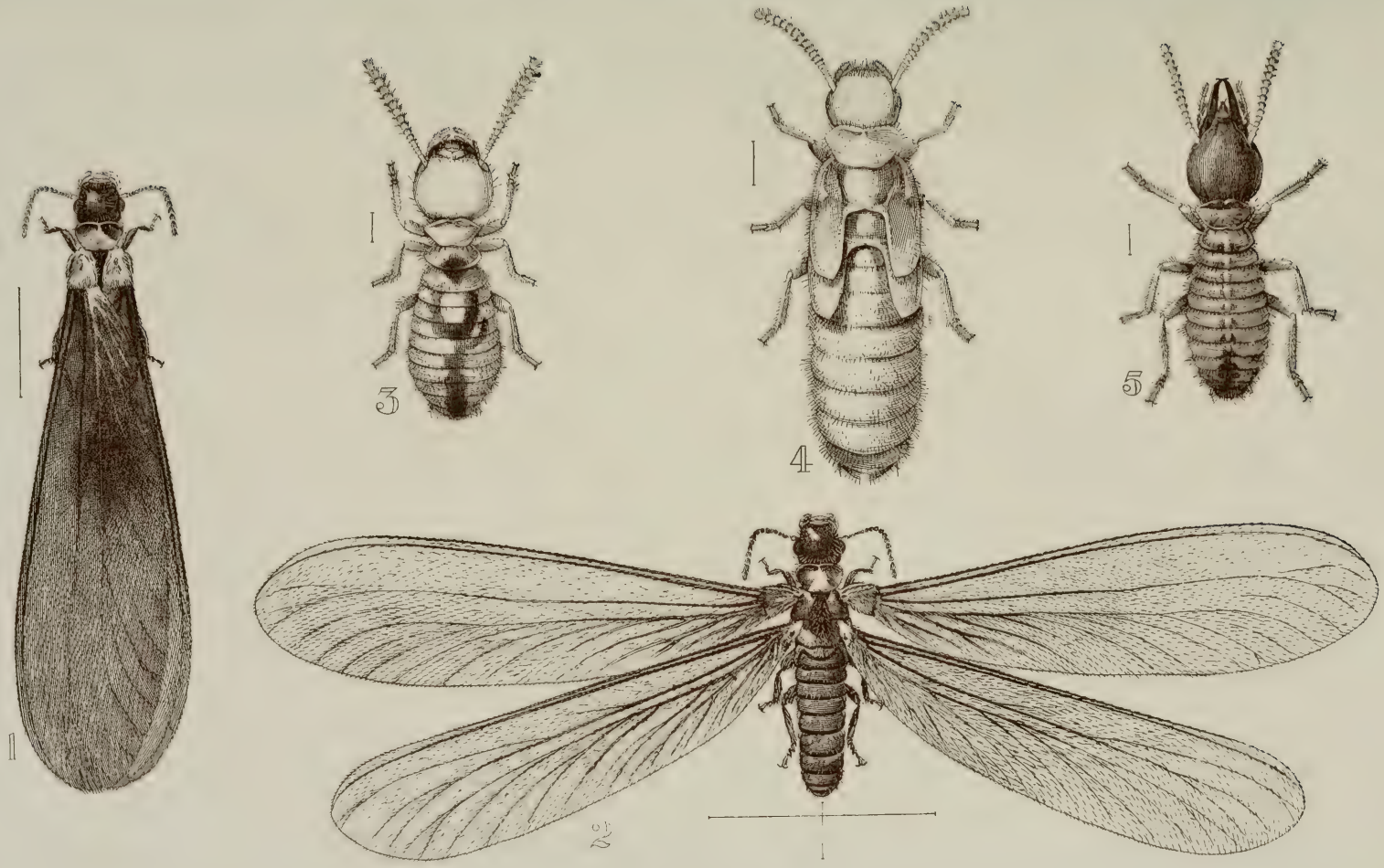
It appears to me that the genera of this group represent the typical white ants that probably were in the first instance arboreal insects, like the *Eutermes*, where the soldiers had the head produced into a snout or tubular process above the mouth connected with a chamber occupying the greater portion of the posterior part of the head, which contained a honey-like liquid that could be forced at will through the snout, and be used as a means of offence or defence. In the *Coptotermes* we find an intermediate group of termites that possess the chamber at the base of the head in a more modified manner, connected with a channel opening out as a circular aperture in front of the head, through which a similar fluid can be discharged, but at the same time this is supplemented by a pair of stout cutting jaws with which the soldier can snip off the head of an enemy, as well as smother him with this viscid matter. These may have at one time combined the terrestrial and arboreal habits, and thus connect the true ground-haunting *Termites* which, furnished with a pair of stout cutting jaws, do not possess the apparatus that enables them to discharge an offensive fluid to rout their enemies.

In the writings of Messrs. Silvestri, Wasmann, and recent describers, a number of new genera have been added to this sub-family, but with our present knowledge of the subject I see no reason to split up our *Termitinæ* into more than these three well-defined groups.

Genus I.—*Termes.*

These termites have large rounded heads, furnished with large prominent eyes composed of many facets, small ocelli, situated between the eyes, and antennæ composed of rounded bead-like segments, varying in number from 13 to 20. The prothorax heart-shaped, flattened and smaller than the head; the wings ample, and often clouded or semi-transparent. The jaws of the soldiers are produced in front of the head and are regular in form, and, when toothed, with the same number of serrations on either side.

This group contains a number of the most typical white ants, many of which build well-defined nests or termitaria, in which they live in countless numbers, or colonies of only a few hundred. Ten species have been recorded from Australia from all parts of the continent.



WHITE ANTS.

1 and 2. Male and Female Winged White Ants. 3. Worker 4. Nymph 5. Soldier

SYNOPSIS OF SPECIES on structure of head of soldier.

1. *Termes ferox.* Head twice the length of breadth; jaws slender, untoothed, but slightly roughened on inner edge; labrum large; antennæ 15-jointed.

2. *Termes paradoxus.* Head longer than broad, truncate in front; jaws long, slender, untoothed, turning sharply over each other to the base; labrum small; antennæ 17-jointed.

3. *Termes serratus.* Head slender, much longer than broad; jaws slender, standing out in front of head, finely serrate along the inner edges; labrum rounded at the tip; antennæ 13-jointed.

4. *Termes turneri.* Head large, longer than broad; jaws slender, with two sharp teeth near tips; labrum large, rounded at the tip; antennæ 13-jointed.

5. *Termes meridionalis.* Head spherical; jaws curving round at the tips, deeply cut out at base on inner margin; labrum broad, rounded; antennæ 15-jointed.

6. *Termes rubriceps.* Head very large, rounded; jaws large, stout, curving round, angular tooth in centre; labrum very small; antennæ 17-jointed.

7. *Termes errabundus.* Head broad, circular; jaws short, stout at base, with one large upper tooth and two smaller ones below; labrum very broad; antennæ 25-jointed.

8. *Termes perniger.* Head as broad as long; jaws sickle-shaped, with long slender tooth in centre; labrum large, rounded at tip; antennæ 17-jointed.

9. *Termes krisiformis.* Head longer than broad, truncate in front; jaws curved upward, and twisted at tips; labrum small, truncate at the tips; antennæ 14-jointed.

10. *Termes australis.* (Soldier unknown. Described from winged forms only.)

The Snapper White Ant (*Termes ferox*, Froggatt).

The winged termites are common in the nests early in February, and are slender delicate black insects with a very feeble flight; the body is of a dark chestnut brown, with the under surface much lighter, hairy, and under $\frac{1}{2}$ an inch in length. The soldier is under $\frac{1}{4}$ of an inch in length, with long, slender, pale yellow head, rounded behind, the sides parallel to the base of the antennæ, and truncate in front; the slender sabre-

shaped jaws turning over each other at the tip; the labrum long, narrow, and pointed at the tip. Antennæ long, 15-jointed.

This is a common species about Sydney, living in small colonies under logs or stones, or dry earthern banks, and sometimes forming their galleries in the base of the walls of the milk termites' nest. They seem to have no regular structure in the galleries, which are always well defined, and of a very pale chocolate brown colour when exposed, but run out at all angles. The soldiers are usually very numerous in proportion to the workers, and very pugnacious, turning round, while the paler white workers make for cover, and snapping their jaws together with a distinct click, as the two jaws strike. They all seem very sensitive to light, and retreat to the burrows leading downward as soon as the galleries are broken. The colonies, though abundant in the bush around Sydney, as a rule consist of only a few hundred individuals.

Termes paradoxus, Froggatt.

This species was obtained in small colonies under logs in the Mackay district, Queensland, by the late Mr. Gilbert Turner, and, as far as I know, is local in its range.

The winged termite is of a general light brown colour, with pale fuscous wings darkest near the body, thickly covered with fine hairs, and under ½ an inch in length to the tip of the folded wings.

The soldier has a light yellow-coloured head, with dark ferruginous jaws, black at the tips; head much longer than broad, rounded behind, parallel on the sides, and truncate behind the jaws; the antennæ 17-jointed, slender; labrum broadly rounded at the tip, rather long; the jaws slender, without teeth, springing from the centre of the head, slightly curved, and when at rest crossing sharp over each other. Length under ¼ of an inch.

The Serrate-jawed White Ant (*Termes serratus*, Froggatt).

The winged form of this species unknown. The soldier has a bright ferruginous head, darkest in front, with black-tipped jaws; antennæ and palpi light brown, prothorax pale yellow. The head is long and slender, rounded behind, but almost straight in front behind the jaws. The antennæ consists of thirteen slender joints; the labrum, broadest at the base, parallel on the sides to the spade-shaped apex. The jaws very slender, springing from the centre of the head, narrow at the base and nearly as long as the head, curving in and crossing at the tips, finely serrate on the inner edge. The worker is about the same length as the soldier, viz., 2 lines, dull white with a pale yellow head. This is a rare species, received from Torren's Creek, North-western Queensland.

Turner's White Ant (*Termes Turneri*, Froggatt).

The members of this species construct small nests from 1 to 2 feet in height, of an irregular cone shape, and up to 18 inches in diameter at

the base. Turner found the queen's cell about the centre of the nest, nearer the base and of the usual regular form, measuring about 2½ inches in diameter. The dark castaneous winged forms were noticed flying about at Mackay, Queensland, where the nests were plentiful in the scrub towards the end of October; and nests examined at that time were full of winged termites ready to emerge.

I afterwards found nests of this species along the boundary fence between Queensland and New South Wales, at the Tweed Heads, in October, when they also contained winged termites. This brings the ranges of this species a long way south.

The winged termites are under ½ an inch in length, slender and nearly black. The queen has the abdominal plates light brown, and her abdomen measures up to an inch in length.

The soldier is pale ochreous, with ferruginous jaws, black at the tips, and measures under ¼ of an inch in length. The head is large, longer than broad, with the sides straight, curving round in front from the base of the antennæ to the jaws, which spring out from the middle of the head and are slender and untoothed. The labrum, broad and covering the base of the jaws, is rounded on the sides, and spade-shaped at the extremity; antennæ composed of thirteen short slender joints, and the prothorax small.

The workers have the head brownish yellow, with dark spots on the sides of the forehead, somewhat longer than broad, with well-defined sutures in front; the abdomen large, of an elongate oval shape.

The Meridonial White Ant (*Termes meridionalis*, Froggatt).

I have not been able to identify the perfect winged form of this remarkable species, but the form of the soldier is very distinct and characteristic. It has the head almost spherical, slightly longer than broad, rounded behind, and sloping in to the base of the jaws, which are falcate, curving round at the tips, the inner edge smooth from the tip to about a third of the way down, when they are sharply cut out and narrow to the base of the labrum, which is short and rounded. The antennæ, composed of fifteen joints, are slender. The head is bright yellow, with dark ferruginous jaws, and the body very white, the whole insect under ¼ of an inch in length. The worker is broad and stout in proportion to the length, and has a very noticeable white angular patch in the centre of the forehead.

This is the termite that is remarkable for constructing the "meridional" or "magnetic" nests found in the vicinity of the Bloomfield River, North Queensland, and Palmerston, Port Darwin. Mr. N. Holtze, who collected the soldiers and workers from these nests in the Northern Territory, near Palmerston, and photographed the nests for me, says, "These nests average from 10 to 12 feet in length, built in the form of a wall, convex

on one side and concave on the other, the sides respectively facing the rising and setting sun." They average about 8 feet in height, the top straight, crowned with irregular little turrets.

In the "Report of the Horn Scientific Expedition to Central Australia, 1896," Professor Spencer says, "At one spot we came across a small patch of the mound nests of what are called the "meridional" or "compass" ants. These are found in other parts of Australia, such as near Cape York and Port Darwin, and the curious feature about them is that the mound, which is 3, 4, or even 5 feet high, is flattened from side to side in such a way that the broad sides face east and west, and the narrow ends north and south; as it tapers upward it has, seen from the north to south, a wedge shape. There were, altogether, perhaps a hundred of these occupying half an acre of ground, and their shape and bright red colour render them very striking objects. Unfortunately, we met with them in the middle of a long march, when it was impossible to stop and examine them, and my hope that we should afterwards meet with others in similar country was not realized. They are made and occupied by a species of termite, or white ant, and the only other white ant mounds which we saw were a few small grey-coloured ones about 18 inches high on some flats near Lake Amadeus."

A great deal of interest has been taken by naturalists as to the reason of this termitaria always being built on these angles, and Mr. Jack, in a paper entitled "Notes on the Meridional Ant Hill of the Cape York Peninsula," published in the "Proceedings of the Royal Society of Queensland, 1897," after describing their structure, advances this theory: "The reason of their being built at this angle is to secure the maximum of desiccation. They do not repair these nests in the long dry season; but when the wet season sets in repair all damages. Its safety lies in its being dried as quickly as possible. In tropical latitudes it is obvious that this drying can best be secured by placing the longer axis of the structure north and south, so that the rays of the sun may beat upon it during the greater part of the day." A short account of the form of these nests is given in the chapter on Termitidæ in the "Cambridge Natural History," Vol. V, p. 18, with a sketch of a drawing by J. J. Walker, R.N., given to Dr. Sharp. Saville Kent has given some fine reproductions of photographs of these nests in his "Naturalist in Australia."

This species has a very wide range over Australia, though it is only in some places that it constructs nests; in other places, it lives in small colonies under logs or stones; and from the latter situations I have had specimens from Kalgoorlie (West Australia), Mackay (Queensland), and many inland places in New South Wales.

The Red-headed White Ant (*Termes rubriceps*, Froggatt).

The winged form of this handsome termite is unknown; they live in small colonies in the dry parts of Central Australia, and, during the Horn Expedition, Professor Spencer obtained several small lots. In one tube of specimens was a note that they were taken from a nest at the roots of

a tussock of spinifex grass. Later on I received several tubes containing this species from my father, who collected them in the Kalgoorlie district, Western Australia, so that they probably have a wide range over the interior. The soldier has the head and jaws bright reddish brown, and the upper surface of the thorax brownish; the legs spiny; abdomen covered with short hairs; and measures $\frac{1}{4}$ of an inch long. The head is very large and broad, rounded behind and on the sides to base of the jaws, which are very stout at the base, curving round to a slender point, with a large angular tooth above the tip of the small rounded labrum; the antennæ 17-jointed, long and slender.

The Large White Ant (*Termes errabundus*, Froggatt).

The soldier is $\frac{1}{2}$ an inch in length, with a bright ferruginous head; black jaws, with all but the abdomen tinted with yellow; the latter as usual being dull white. The head is a little longer than broad, rounded behind right up to the base of the jaws, with the antennæ well round the side of the head, and not so close to the jaws as usual, and are composed of twenty-five slender joints. The labrum is large, rounded at the apex; the jaws short, stout, rounded and curving over each other at the extremity, with a large angular tooth about a third of the distance from the tip. The worker is larger than the male, with a pale yellow short rounded head furnished with very powerful jaws.

This is our largest species of the genus, and is common all over North Queensland, Northern Territory, and the north-west part of Western Australia. It gets into the wood work of houses, into the station storehouses, and is responsible for most of the damage of this kind in North Queensland. The real nest of this species (if it constructs one) is unknown, and they are usually found in small colonies under logs and timber. Mr. Mansbridge, writing from Hall's Creek, Kimberley, Western Australia, says, "These termites were taken from a piece of timber lying on the ground; they are very destructive, and will in a very short time destroy deal boards (to which they are very partial) if left in a dark corner or shady spot."

The Dark Brown White Ant (*Termes perniger*, Froggatt).

The winged forms, or regular nest of this species are unknown, but the very distinctive colour and the immense jaws of the soldier easily distinguish it from any other known Australian termite.

The soldier measures about $\frac{1}{3}$ of an inch in length, rather stout and broad in proportion; the head is black, with ferruginous jaws tipped with the former colour; the rest of the body and legs dark brown. The head is large, broad, rounded on the sides to the base of the jaws, which are as long as the head, broad at the base, curving round like a pair of sickle blades, crossing each other when at rest, with a slender pointed tooth standing sharply out in a line with the apex of the labrum. The antennæ long and slender, composed of seventeen joints; the labrum large, rounded to the tip. The prothorax is small, flattened and wrinkled; the legs long,

slender, and somewhat spiny; the abdomen large and clothed with fine hairs. The workers are very dark-coloured, the dorsal surface of the abdomen even brown, and quite as large as the soldier.

My father first found these white ants under a log at Kalgoorlie, Western Australia, and wrote, "These soldiers are very savage, when touched exuding a white milky substance, at the same time biting so viciously that if once they caught hold with their enormous jaws, you could pull their heads off before they would let go."

My father later on in the season sent me another lot which he noticed coming out of the ground after a shower; each one of these was clinging to the bit of grass with which it had been picked up by its closed jaws when received in the tube of spirits.

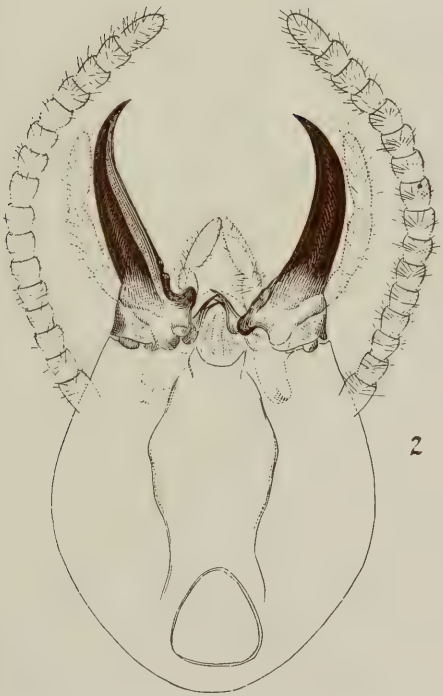
The range of this species is evidently considerable, as Mr. Tryon has shown me specimens of this termite from Charlieville, on the Warrego, Western Queensland.

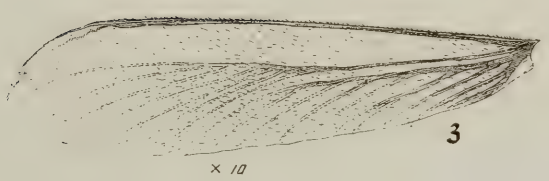
The Dagger-jawed White Ant (*Termes krisiformis*, Froggatt).

This species was for a long time only known to me from small colonies of soldiers and workers found under logs about Sutherland, near Sydney, but last summer (1904) I came across a number of small rounded nests in the scrub near the Bulli Pass, which proved to be the home of this termite. They were scattered about in the thick forest on the hillside, and were of a rounded form, about 6 inches in height and a foot in diameter at the base, composed of earth more than woody matter, full of irregular galleries and a very primitive queen chamber, with abundance of eggs, but no winged forms. In the end of February, this season (1905), at Noundoc, about 45 miles east of Walcha, in the New England district, in similar forest country, I found this to be a common species, living in small communities under stones and logs; and under one found a large colony full of winged forms, workers, and soldiers.

Winged form (previously unknown) black to dark brown on thorax and abdomen, rest ochreous; wings black, clothed with fine reddish hairs, thickest on abdomen. Length of body 2½ lines; length to tip of wings ½ inch. Head broad, rounded behind, swelling out in front; clypeus pale, rounded, projecting, lobed; antennæ slender, 14-jointed; eyes large, projecting; ocelli small, pale brown, well in front of eyes; jaws small, bright ferruginous, with two slender teeth at tips, smaller one in centre, and large, stout one at base. Prothorax flattened, very rugose, truncate in front, rounded behind; legs stout. Wings long, rounded at tips, scapular shield short, rough. The costal and sub-costal nervures stout, rounded to the tip; medium nervure running through upper half of wing unbranched; sub-median with eight oblique nervures. The abdomen broad, rounded at tip and furnished with very small cerci.

The soldier has a pale yellow broad, somewhat square head, longer than broad, rounded behind, truncate behind the jaws, with slender 14-jointed antennæ; the jaws springing out from the front of the head, slender, turned up, then curved down, of an irregular thickness, again turning





WHITE ANTS (TERMES LACTUS).

1. *Head of Worker.* 2. *Head of Soldier.*
3. *Wing of Perfect Insect.*

round to the extremity into an auger-shaped tip. They measure ¼ of an inch in length; the worker a little less, but stouter in proportion. The soldiers are very few in proportion to the workers and seldom show fight, hiding as soon as exposed.

The Common White Ant (*Termes australis*, Walker).

The soldier of this species is unknown, as they were described by Walker from winged specimens collected, probably round a lamp. Obtained in South Australia.

The winged forms are light ferruginous, with darker heads, measuring ½ an inch to the tip of the wings.

Walker described workers and soldiers as belonging to this species, but Hagen, who examined the types, says that they did not belong to the winged termite, but were *Calotermes*. I have not been able to discover the nest of this species.

Genus II.—*Coptotermes*.

This genus was created by Wasmann to contain a species of white ant closely allied to the members of the genus *Termes*, but furnished with an opening in front of the head above the labrum and jaws, through which the soldier can discharge a fluid like *Eutermes*, though at the same time possessing the powerful curved fighting jaws of the typical termes.

In other habits they agree with the first genus of this division, building large termitaria, and living in large communities, with large numbers of soldiers. Three species are known in Australia, among them our commonest mound-building species.

SYNOPTICAL TABLE based on structure of head of soldier.

1. *Coptotermes lacteus*. Head pear-shaped; jaws large, sabre-shaped, untoothed; labrum pointed; antennæ 16-jointed; frontal opening distinct but not projecting.
2. *Coptotermes acinaciformis*. Head broader behind; larger jaws, similar; antennæ 17-jointed; frontal opening situated at extremity of forehead, above the jaws, which are contracted.
3. *Coptotermes rafferyi*. Head smaller than last; antennæ 15-jointed; closely allied.

The Milk White Ant (*Coptotermes* [*Termes*] *lacteus*, Froggatt).

This species was first described under the name of *Termes lactis* by me in the *Agricultural Gazette* of New South Wales, p. 297, with plate, in May, 1897, and later on in the same year a technical description was given in the "Proceedings of the Linnean Society of New South Wales."

It is the common species in Australia that is responsible for nearly all the damage done to houses; I have never found any other species of this genus in houses, but one or two species of the allied *Eutermes* often get into fences and outside woodwork in the bush. It is rather curious that while

the nests of this species are not found about the neighbourhood of Sydney, where they simply form colonies in old stumps, under logs and houses. that they build such characteristic domed nests in other districts. The large termite nest met with along the South Coast, the scrubby country of Colo Vale, Moss Vale, and up into Southern Queensland, is the home of this species. It measures up to 6 feet in height, broadest at the base, tapering very little on the sides, and broadly rounded on the summit. The outer clay covering is very thick and compact, without any opening on the surface except when the workers cut galleries through the walls in November to let out the winged males and females, and as soon as they have emerged the holes are filled up with fresh clay. Enfolded in this clay covering is an irregular mass of granulated, honeycombed, woody matter, which has at one time been wood, but has been chewed up and voided by the insects and produced into a regular papier-mache-like substance; it is seldom in contact with the clay except at the base, and fits to the outward form of the termitarium: The base of the nest, which consists of a regular network of galleries, generally extends about a foot below the surrounding surface of the ground, from beneath which several large galleries lead away into the soil and are the main roads out of the nest to the surrounding forest. Above the network portion of the base of the nest, which is easily detached from the ground, the structure of the galleries becomes more solid, and the royal chamber nearly in the centre of the mass is surrounded with terrace-like solid sheets of a lighter colour, the central chamber being a convex cavity on a level floor about the size of an ordinary saucer; just below on the side will be found more open galleries containing piles of eggs, like semi-transparent grains of sugar, which are removed by the workers from the royal chamber. There are several openings leading off from the floor by which the attendant workers can come in and out, but they are not large enough for the queen, if she is able to move freely (which she is not usually able to do) to get out of her cell. It is noticeable that the egg chambers and queen cell are always situated well above the ground level, so that even if the ground was flooded they are out of danger. Above the queen is a mass of very fine laminated material as thin as brown paper, folding up into fine galleries, curving round into an irregularly rounded ball as big as a man's head, in which the tiny larvæ swarm, and which has been termed the "nursery." The rest of the termitaria consists of more or less solid masses of material, full of chambers and galleries, through which the workers and soldiers are mixed up in no regular order. Sometimes the clay walls contain short galleries in which workers and soldiers are found, but this is not usually the case. In November, on the Shoalhaven, where I opened a number of nests, several were found with keyhole-like slits in the walls, with a cluster of soldiers at the outer opening, with their jaws facing out, standing guard, while behind them the galleries were packed with the winged ones ready to emerge at the appointed time when the soldiers would give free exit, which turned out to be just before sunset.

The winged forms are almost black in colour, with no very distinct characters from several other species; but both the soldiers and workers are very white, with the head pale yellow. The soldier has a somewhat pear-shaped head, with 16-jointed antennæ; large, untoothed curved sabre-shaped jaws, usually meeting or crossed at the tip, and a tubular opening in front above the labrum, through which, when touched, he can discharge a globule of white sticky fluid, by which the species is easily distinguished from any other found about Sydney. It is met with in all sorts of situations, under logs, turning over stones, under dead bark on tree trunks, in the roots or stems of old or damaged fruit trees, and in woodwork of houses. When disturbed the workers always hurry away, but the soldiers only retreat to the entrance of the galleries leading downwards, where they stand with their jaws just projecting and their antennæ moving sideways. If the gap is in the wall of a regular nest, the soldiers remain there until the workers return with grains of earth which they place on the fracture, then turn round, void a drop of what looks like liquid mud, hurry off, while the next one steps in front of the soldiers and places its load on the top of the other, treats it in the same manner, and is followed by another until the opening is soon closed up, and the last one sees is the antennæ of the soldiers waving behind the barricade. The rebuilding of the broken wall, if the damage is serious, is only of a temporary character over the galleries leading in to the nest; they seem to understand that they cannot replace the mass of clay that has been broken out at once; but this is gradually filled in by nocturnal workers who, in a very few days, will replace the gap and level the surface down to its original shape.

The Northern Milk Termite (*Coptotermes* [*Termes*] *acinaciformis*, Froggatt).

This termite differs from the last in the perfect insect having hyaline wings with light brown nervures, and is of a general light brown colour, and clothed with fine hairs. It measures just over ½ an inch from the front of the head to the tip of the closed wings. The soldier has the head larger than the milk termite, broader behind, with 17-jointed antennæ, and large, curved, untoothed jaws, with a similar opening in the front of the forehead. It is somewhat larger, and there is a curious pattern down the centre of the abdomen that is very distinctive.

The first lot of specimens were obtained by Mr. W. O. Mansbridge, at Hall's Creek, Kimberley, North-western Australia, with the information that they were taken from the heart of a gum tree some 20 feet from the ground, and had completely eaten the centre out, only a mere shell remaining; most of the trees in this district are eaten out in the same manner by this white ant. This species was afterwards sent to me, from the Kalgoorlie district, by my father in 1898.

(*Coptotermes* [*Termes*] *rafferyi*, Wasmann).

This species was described by Wasmann from specimens of soldiers and workers which Raffray sent to him, in an Appendix, "Description of a

Termite associated with a Pselaphid," "Proceedings of the Linnean Society, New South Wales," vol. XXV, p. 244, 1900.

These termites and beetles were collected by Lea at Swan River, Western Australia.

Genus III.—*Eutermes.*

In general structure the winged forms are closely allied to the first genus, the chief difference being in the structure of the scapular shield, or basal portion of the wings. They are all dark brown insects, with 12–16-jointed antennæ, with the terminal joints slightly thickened.

In the soldiers the structure is very different, for instead of the double jaws projecting in front the fore portion of the head is produced into a snout (*nasuti*), like an awl, which is tubular, and open at the extremity, connected with a chamber in the head, from which, when the soldier is attacked, it can eject a drop of protective fluid more or less deadly to its enemies. When a nest is damaged, these tiny little soldiers swarm out and stand guard in a most fearless manner until the workers have sealed it up again.

They costruct all kinds of nests, sometimes on the ground, over stumps, grass roots, or under bark and logs, often very small and irregular in structure, though the largest nest known is formed by *E. pyriformis*, in North Australia. The nests formed upon the limbs of trees are constructed by members of this genus. There are seven species described from Australia, and when the country has been explored this number should be largely increased.

Synoptical table of the members of the genus *Eutermes*, based on structure of head of soldier.

1. *Eutermes magnus*, Froggatt. Head dark, castaneous; hemispherical snout, nearly as long as rest of head; antennæ 14-jointed.
2. *Eutermes triodiæ*, Froggatt. Head darkest on sides of head and snout, almost round; snout short, showing slight suture through head; antennæ 14-jointed.
3. *Eutermes tumuli*, Froggatt. Head reddish orange; snout darker; both head and snout slender, rounded behind; antennæ 12-jointed.
4. *Eutermes pyriformis*, Froggatt. Head reddish brown; tip of snout same colour; head broadly rounded; snout shorter than head; antennæ banded, 14 joints.
5. *Eutermes hastilis*, Froggatt. Head light reddish brown; snout darkest; head broad behind, compressed on sides; snout short; antennæ 13-jointed.
6. *Eutermes fumipennis*, Walker. Head dark chestnut, snout black; head pear-shaped from above; snout slender and pointed; antennæ 13-jointed.
7. *Eutermes fumigatus*, Brauer. Head light-coloured, darkest on sides and snout; head broad behind, tapering to snout, which is short, and broad at base; antennæ 13-jointed.

The Large Eutermes (*Eutermes magnus*, Froggatt).

This species is not uncommon in North Queensland, where it builds a dome-shaped nest, from 2 to 3 feet in height and 3 to 4 feet in diameter, upon dry, basaltic, scrubby ridges. The winged forms emerge in the middle of November, and are remarkable for their size—nearly $1\frac{1}{4}$ inches in length to the tip of the closed wings, and nearly $\frac{3}{4}$ of an inch to the tip of the body—and has 16-jointed antennæ. This is one of the darkest-coloured forms of this genus.

The soldier is under $\frac{1}{4}$ of an inch in length, with the head dark brown, and the centre of thorax and abdominal plates pale rusty red. The head is furnished with long palpi, and fourteen joints in the antennæ; the snout nearly as long as the rounded portion of the head.

The worker has the upper surface of the head brown, with cross sutures of a lighter colour, and 15-jointed antennæ.

The Spinifex Eutermes (*Eutermes triodiæ*, Froggatt).

This is the common mound-building species in the Hall's Creek District, Kimberley, Western Australia, that form their nests on the sides of the slate ridges. They appear to always start by swarming over a clump of spinifex grass, which grows to a height of about 2 feet, and construct a rounded, dome-shaped termitarium, covered with earthy matter on the outer surface, up to 6 or 8 feet in height, rounded at the base, and of an almost uniform diameter to the regularly-rounded apex.

The winged forms are dark brown, with fuscous wings, and measure nearly $\frac{1}{2}$ an inch in length, with the body about $\frac{1}{4}$ inch. The head is large, clothed with fine hairs, and the antennæ composed of fifteen short, rounded segments. The soldier measures about $\frac{1}{6}$ of an inch in length, and has the head dark brown, with the tip of the snout reddish; the antennæ with fourteen slender joints. The worker is slightly larger than the soldier, with the same number of joints in the antennæ.

The Turret Eutermes (*Eutermes tumuli*, Froggatt).

This is the only mound-building species in the Kalgoorlie district, Western Australia, the nests varying from a few inches in height to upwards of a foot, and about the same in diameter at the base, and are always found under the shelter of low, scrubby bushes. During the dry season the nests are uninhabited, and the outer walls become so thin that they crumble away, until the ends of the galleries opening outwards are exposed with the first rain storms.

My father, who made these observations, found them suddenly appear in the previously abandoned nests in March, after the rains, and set to work to mend and patch up the outer walls. In the following October numbers of winged forms were obtained. In these nests he also found large stores of grey pellets, which on examination proved to be masticated grass, rolled up into little balls, a form of food that has not been met with, as far as I know, in any other white ant termitaria.

These nests were recorded during the Horn Expedition from several places under shelter of clumps of spinifex in Central Australia.

The winged form measures ½ an inch in length to the tip of the wings, and just half that to the tip of the body, and is of the usual dark brown tint, and clothed with fine hairs. Antennæ 16-jointed. The soldier has a dull reddish orange-coloured head, with the tip of the snout almost black; the thorax and abdomen brown, with pale segmental divisions. Antennæ slender, 12-jointed. Length of body ⅙ of an inch. The worker with reddish-brown head, the rest of upper surface light brown; a little longer than the soldier.

The Great Mound-nest Eutermes (*Eutermes pyriformis*, Froggatt).

The winged forms have never been obtained from the nests for determination, though probably common just before the wet season. The soldier, measuring under ⅓ of an inch in length, has a reddish brown, smooth, shining head; the base of the snout black and the tip reddish. The worker, slightly larger than the former, has a pale dull yellow head, blotched with brown, and 15-jointed antennæ.

This is the white ant that constructs some of the tallest nests in the world, and comes from the neighbourhood of Port Darwin, in North Australia. These nests average about 4 feet in diameter at the base, running up in a regular fluted columnar form, with irregular projecting buttresses, to a height of fully 18 feet, of an almost uniform width, and terminating in an irregular pointed summit. These nests appear to be built in the first instance over a dead tree stump or broken trunk, which is gradually encased with clay on the outside, while the interior was eaten out, and replaced with granulated masses of chewed wood.

The Red-headed Eutermes (*Eutermes hastilis*, Froggatt).

This is the typical eutermes in the Mackay district, Queensland, where they form small rounded nests about a foot in diameter at the base, but seldom more than half that in height.

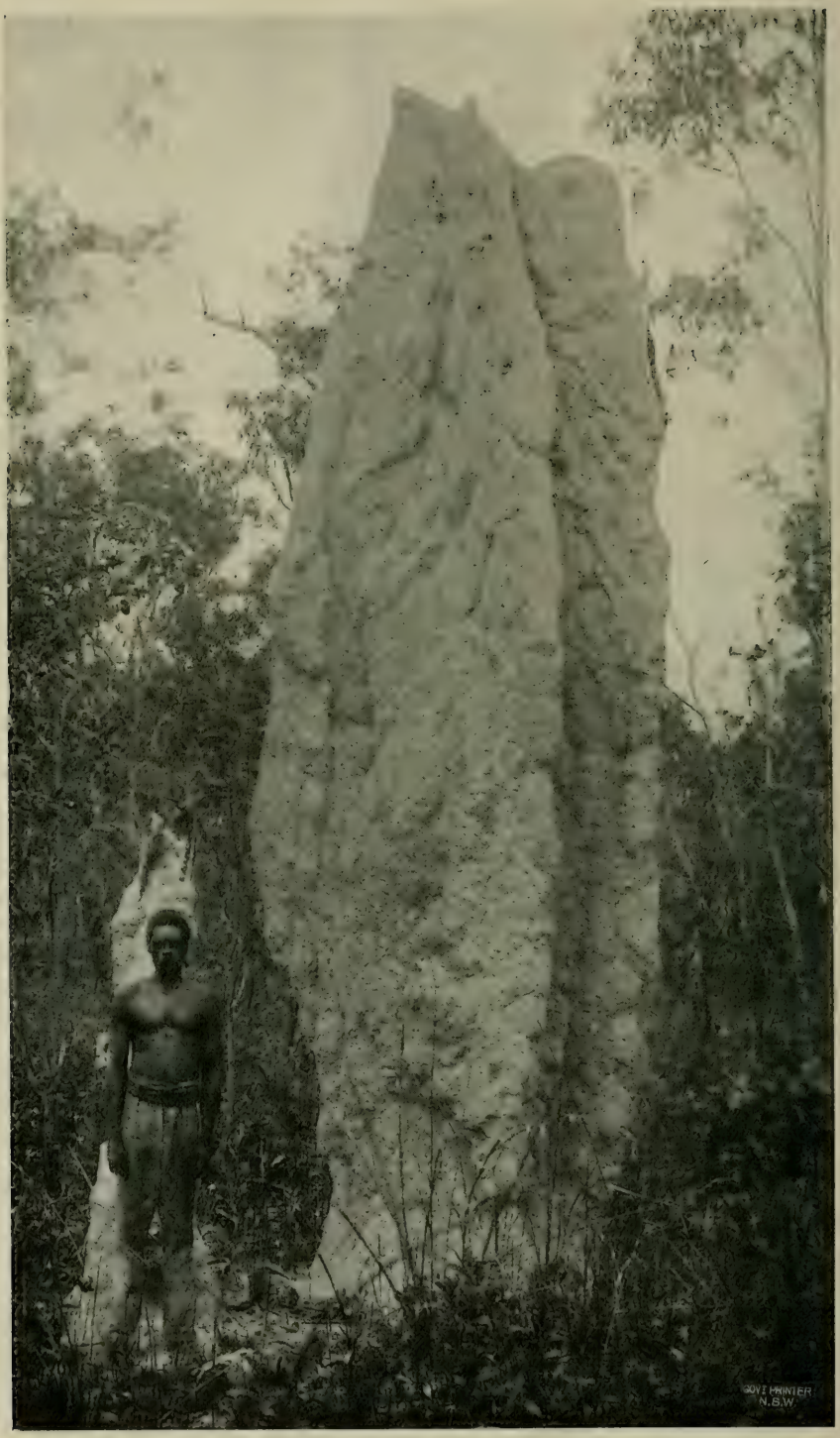
The winged form is of the usual dark brown tint, with lightly barred antennæ composed of fifteen joints. It measures ½ an inch in length to the tip of the wings and about ⅓ to the tip of the body. The soldier differs from both *E. fumipennis* and *E. fumigatus* in the bright rusty-red colour of the head, and is intermediate in size between the two. The head viewed from above is pear-shaped; the snout slender and pointed; with 13-jointed antennæ.

This appears to be a local species, and I have not seen it from any other part of the country.

The Common Pale Eutermes (*Eutermes fumipennis*, Walker).

This is the largest of the two species common to this State, and is much lighter in colour than the smaller species. They are found in all kinds of situations, sometimes forming irregular galleries under logs and stones, but often constructing regular rounded domed nests over logs up to 2 or 3 feet in height, but differing from the true termes' nests in having no distinct earthy wall or outside shell, the earthy admixture forming the

The Great Mound-Nest White Ant *(Eutermes pyriformis).*
Palmerston, Port Darwin.



Nest of the Great Mound-Nest White Ant, *Eutermes pyriformis* **(uncommon).**
From Palmerston, Port Darwin.

covering gradually becoming more hard and woody as one comes towards the centre; and the base of the nest extends for some inches below the surface of the soil. They also build the typical "Negro head" nests up in the branches of live trees; these are of an irregular rounded form almost exclusively composed of woody matter, and are soft and friable when broken, and the internal structure is very irregular. I have also found one of these "negro head" nests on the top of a large rock near Manly, probably started over a small stump which had been eaten right out; this was connected with the ground below with regular clay-covered galleries running round the rock, and in all those found in the tree tops galleries always lead down the trunk more or less hidden by the inequalities of the bark, up and down which the white ants are always hurrying backwards and forwards.

The winged forms are of a general light reddish-brown tint, with pale fuscous wings, measuring nearly $\frac{3}{4}$ of an inch to the tip of the wings, and over $\frac{1}{3}$ of an inch to the extremity of the abdomen; the large flattened head furnished with slender antennæ consisting of fifteen joints. The queen measures 1 inch in length and $\frac{1}{3}$ of an inch in diameter. The worker is pale yellowish-brown, the brownish blotched head with a double white suture dividing it, and a reddish spot on either side in front. It measures $\frac{1}{4}$ of an inch in length.

The soldier has chestnut-coloured head, with the snout much darker, and 13-jointed antennæ. It measures $\frac{1}{6}$ of an inch in length. It has a wide range over the whole of Australia, and is found in all kinds of situations, sharing with *Termes lacteus* the credit of doing most of the damage to woodwork of houses and fences in Australia.

The Common Dark Eutermes (*Eutermes fumigatus*, Brauer).

Two species of Eutermes are common in the neighbourhood of Sydney, and are easily distinguished from each other by the size and colour of the head of the soldier. This is the smaller of the two, with the dark-headed soldiers. They appear to never construct nests, but form a network of irregular galleries under logs, sheets of bark, and stones, but sometimes infest old fences or exposed woodwork.

The queen's chamber is often found when turning over the log under which the nest has been made, and has no apparent structure other than that of the surrounding galleries. The exodus of winged termites from the nest takes place early in November; supplementary queens are sometimes found in these nests. I received eight taken out of a nest near Uralla.

The winged forms are dark-brown, with the under surface, antennæ, and legs lighter-coloured, measuring about $\frac{1}{4}$ of an inch to the tips of the body, and nearly $\frac{1}{2}$ an inch to the top of the folded wings, and has 14-jointed antennæ. The soldier measures about 2 lines in length ($\frac{1}{6}$ of an inch), and the antennæ are 13-jointed. The worker is as long as the

soldier, with a light brown head, blotched in the centre of the upper surface with a darker reddish-brown tint, with a pale line of suture down the centre; and antennæ composed of fourteen joints. It has a wide range over the coastal districts of New South Wales, and probably will be found extending into the other States.

Prevention and Methods of dealing with White Ants.

Termites are individually very delicate little creatures that can be easily destroyed by any contact poison if once found, and their whereabouts noticed in time; so that it is not difficult to check or drive them away in the first instance.

The food of these insects is wood or vegetable matter of all kinds, and the wonderful instinct or sense of smell that enables them to find their way upwards through feet of clay or brickwork to the wood above is very remarkable.

Therefore, as prevention is better than cure, the more perfectly the house being built is isolated from the ground beneath the better chance there is of keeping out the white ants. The first thing to do before building any kind of house in a district where white ants are known to be troublesome is to thoroughly examine the proposed site for all stumps, roots, or dead wood, and remove everything found; if it is practical to remove all the surface earth that is being built over for a depth of 6 inches or more, so much the better; some foreign authority recently advised deeply ploughing the site first, and claimed that he had never had a house infested with white ants where this practice had been followed.

All floors should be raised above the surrounding level, so high that a man could crawl all over under the building and have access to the woodwork. In many of the cases where houses are badly damaged by white ants the floor joists will be frequently found resting upon or only a few inches off the ground.

In country houses where timber supports or piles are used, they should be charred or tarred, and if ½ a lb. of salt be placed in each hole beneath the post it would be a great preventive; on the top of each a tin or zinc cap should be placed, for, though not everlasting, they help to keep the pests out of all upper woodwork.

Where bricks can be used it is much better to build all supports with them, as they do not attract the termites. The floor joists after they are laid should be thoroughly dressed with wood-preserving oil, to which has been added 1 lb. of arsenic to 4 gallons of oil. If equal parts of washing soda and arsenic are boiled together, the latter will be dissolved and can then be mixed with the oil. This is the basis of all "anti-ant paint" and "white ant exterminators" that are placed upon the market; they can be just as easily compounded at home for less than one quarter the cost. Sometimes after the floor is laid upon the joists the oil will ascend through

the nail holes; but this does no harm, but is rather a proof that the work has been well done.

Of course, it is difficult to perfectly isolate a house from the ground, for often after all the care taken someone may build a flight of steps up to the front without any precautions, furnishing an ideal roadway for the termite; or else someone leans a beam against the wall and gives them another means of ingress. In the country where wood is chiefly used for fuel, and is carted in and stacked close to the house, it is quite evident that logs infested with small colonies of white ants can be easily introduced, which, under favourable conditions, might emerge and find a lodgment elsewhere, and thus get into the house timbers. In North Queensland many of the houses are built upon 11-feet piles, so that there is plenty of room beneath, and in such houses it is seldom that the termites get into the woodwork.

When once the white ants have gained an entrance into a building, the first thing is to find where they started work and the extent and area affected by their depredations. When this has been ascertained, the outer woodwork can be removed, and the damaged timber, where not too far gone, painted with corrosive sublimate (bi-chloride of mercury) which has been dissolved in spirits of wine or water. Sugar or treacle, to which arsenic has been blended, if placed in the excavations they are working, will kill off large numbers, for they feed upon it readily, and even eat the dead ones that have first succumbed to the poison, so that it soon reduces their numbers.

There have been many suggestions made as to the possibility of injecting steam, the fumes of carbolic acid, gas, &c., into the infested timber, but none have been of any practical value. Sometimes the white ants get into a house, and after doing a certain amount of damage, disappear without going any further into the timber. Again, white ants attack a building and may be in it for many years, and it is apparently more or less immune and prevented any serious damage. In the old Naval Depôt, 140 George-street, under the floors there is quite a large nest, which has contained a more or less active colony for many years, yet they never seem to have spread from the large beam where they raised their clay galleries.

The question of white ant resisting or distasteful timber is often raised, and though the hardness or otherwise of wood seems to have little influence on the steel-like jaws of the workers, for they will tunnel through some of our driest dead hard eucalyptus tree trunks with the greatest ease, there is not the least doubt they much prefer some timbers. I have frequently seen red pine boards, round which the white ants have passed, hardly scratched upon the surface, when a clear pine board behind it has been reduced to ribbons. Some of our native woods are much more liable to their attacks, among them sawn stringybark timber. Jarrah is said to resist their attacks, but I have seen a board from West Australia much damaged by them. Desert cypress they are certainly not fond of when sawn up, but in the fallen trees, logs, or telegraph poles they are very

often found hard at work. There is room for valuable experimental work in testing the different timbers as regards their resistant properties to white ants in Australia; something of this kind has been done in other countries. An interesting account is given by H. W. Bates, "On the Prevention of the destruction of Timbers by Termites," in the Transactions of the Entomological Society (London), 1864, Vol. 1, page 185. In "The Technologist" (London), 1865, Vol. V, page 453, the Rev. M. J. Berkeley published an account of termites and remedies based upon a report issued by the Committee of Inquiry into the ravages of the white ants at St. Helena and the means of dealing with them.

In Crichton's History of Arabia, Ancient and Modern (Edinburgh), 1833, an account of the termites destroying live trees is given, which the Arabs protect by plastering the stems with sheep dung. I have been informed by one of my western correspondents that sheep dung has been used in the Hay district to protect trees and timber with very good results. Bossavia states, in an article in "The Technologist" (Vol. V, page 237), that in the gaol at Lucknow, India, a plaster of clay or cowdung mixed with the pulp of the common American aloe was found very serviceable in keeping termites out of the timber.

Orchard trees and root crops damaged.—In the case where live trees are attacked, as is often the case in the drier portions of the interior, it is very difficult to check them, for all the mineral poisons or oils that can be used in the case of timber cannot be applied to living vegetable tissue without damaging the plants treated. In midsummer the watering of the trees only makes matters worse, as it attracts the termites out of the dry soil into the more agreeable moist area. Sometimes the termites come up from below, and finding a weak spot in the trunk or dead root soon burrow up the centre of the trunk, particularly in old peach orchards, so that it is not uncommon to find a large tree snap off, showing the whole of the stem only a pipe covered with the bark. At other times they attack sound fruit trees from the outside, gnawing off the bark below the surface and boring in at the graft scar. In some places nursery stock is greatly damaged in this manner, the bark being gnawed off the cuttings and seedlings. In the case of old trees being infested, the best thing, unless the tree is a very good one and bearing fruit, is to dig it out, roots and all, and burn it with all the termites. The young trees and nursery stock can be cleaned round and washed with carbolic soap, or other strong smelling mixture. In country where the forest comes right up to the orchard fence it is difficult to keep the outer edge of the orchard free from the pests, but if all wood is carefully burned out of the cultivated land, and all logs and termite mounds fired, the orchard will not suffer so much. I have in quite a number of cases found that the habit of filling up drains through the orchard with timber was the probable cause of the termites attacking the trees.

Experiments carried out with kainit (German potash) in the Dubbo district prove that it is a good protection to fruit trees when dug in well about the roots.

Glossary.

Labrum	.. Upper lip above the jaws in front of head.
Ocelli	.. Small simple eyes on top of head in winged forms.
Prothorax ..	.. Front portion of body behind the head
Mesothorax ..	.. Second segment of body behind prothorax.
Metathorax ..	.. Third segment of body, to which the abdomen is joined.
Scapular shield ..	.. Basal portion of wings remaining on the body after the wings are detached.
Nervures ..	.. The veins of the wings, parallel or transverse.
Costal nervure ..	.. Front margin of wing, usually thickened.
Sub-costal nervure	.. The nervure running parallel to costal, immediately behind.
Femora ..	.. The thigh of the leg.
Tibiæ	.. The shank of the leg.
Tibial spines ..	.. Spines at the extremity of shank.
Tarsi	.. The toes or joints of the feet, usually terminating in a double claw.
Abdomen ..	.. The hind portion or body proper, generally consisting of 9 segments.
Cerci	.. Short jointed appendages on either side at the top of the abdomen.

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